# Algae CP

## Public/Large Scale

### Algae CP 1nc

#### Text: The United States federal government should amend relevant definitions in the Energy Independence and Security Act of 2007 to include algae-derived fuels eligible for all tax credits, subsidies, and price supports.

#### Amending the RFS to include price supports for algae spurs green crude production. This provides clean renewable fuel – solves energy dependence and breaks the food/fuel link

Jason Pyle (Chief Executive Officer, Sapphire Energy) June 12 2008 “Renewable Fuels And Food Prices,” CQ Congressional Testimony

First, let me thank the Committee for its leadership on alternative, renewable fuels. Your keen focus and vision have resulted in the first ever Renewable Fuel Standard. Although there will inevitably be elements of RFS that will improve over time, you've guided the country along on the right path. Second, within the RFS debate, I want to thank this Committee for its vision and support for technology neutrality in RFS legislation, even though that vision did not survive final passage. As you predicted by supporting a technology neutral position, we are now seeing the evolution of an entirely new generation of renewable fuels. These fuels transcend the use of food as fuel feedstock. The current dilemma that pits fuel against food is just the first of many consequences of a technology-specific RFS. Without a technology-neutral RFS, this nation will not meet its goals of providing 32 billion gallons of renewable fuel by 2022. Although last year's Energy Independence and Security Act has yet to foster such solutions, this Committee should be applauded for anticipating an ever-expanding universe of alternative and renewable fuels. That's why I am here. I'm Jason Pyle, Chief Executive Officer of Sapphire Energy. Sapphire is one of several of this nation's best technology companies working to produce the next generation of renewable fuels. At Sapphire, we focus on the production of current fuel products, such as gasoline, diesel and aircraft fuel, from completely renewable sources, such as photosynthetic microorganisms, or algae. Our mission is to produce fuels for today's oil and gasoline infrastructure, and two weeks ago we announced that Sapphire had produced the first ever renewable, ASTM-compliant, 91 octane gasoline from microorganisms. Please refer to the attached two documents for more background on Sapphire Energy. The Problem One of the many reasons we have cheap food is the availability of cheap energy. We cannot expect to turn large amounts of food back into energy in an economic manner. In today's debate between food and fuel, we should not have to make a choice. Both are critical to the economy, the environment and the world at large; we should not match one against the other. But when price and demand rise for one, both suffer. Instead of a Pyrrhic choice between food and fuel, I offer the opportunity to transcend the debate and produce ample supplies of both, leading this nation toward energy independence. Instead of a dispute between two basic necessities, we need a dialogue that supports truly sustainable alternative fuel sources. Over the past year we have all seen prices and demand rise for commodities such as corn, sugar and vegetable oil. The entire world now feels the pressure. Daily we are faced with reports of people who struggle to afford essentials. A host of factors has contributed to price increases for food and fuel: weather, heightened demand, a weaker dollar, decreasing supplies. Just like energy, food is linked in a global market. Once we begin fueling our cars with food crops, we witness international repercussions. Riots occurred in Mexico earlier this year over expensive corn flour. This price increase has been attributed to U.S. demand for corn-based ethanol products, leaving less maize available for export. Protests over similar issues have occurred around the world, contributing to inflation and political instability. Even at an increased rate of production, current domestic biofuel processes will meet part, but not all, of U.S. demand. If the entire annual domestic soybean crop of 3 billion bushels were converted to biodiesel at the current efficiency of 1.4 gallons per bushel, it would provide about 6.5% of U.S. diesel fuel production. Though certainly a valuable asset to our fuel supply, it is clear that a spectrum of additional and diverse biofuels sources will be necessary to fulfill demand. Congress first adopted the Renewable Fuels Standard in 2005, but wisely recognized that neither biodiesel nor ethanol would be the final solution. It created the program as a bridge to a new generation of fuels, and established a system of incentives to create a marketplace for new technologies. Congress should consider whether the incentives are neutral and fair. Ask whether these mechanisms will lead to the support and development of fuels that will give America true energy independence. Congress should ensure that the next round of incentives can be applied to advanced technologies such as Sapphire's. American innovation is the heart of our people and our economy; I urge you to support this with additional legislation that promotes a technology-neutral RFS. The Solution Food for fuel concerns are real, but can be managed. Industries such as ethanol from corn and biodiesel from vegetable oil can continue to play an important role in the energy mix. However, if we intend to practically and economically reach the goals of the RFS, we must be ready to rapidly embrace new fuel technologies. We must call on American ingenuity and entrepreneurialism for the solutions. When Congress passed the Energy Policy Act of 2005, it put the country on a path toward an energy future independent of imported resources. As Americans, we must support this vision. We should strive to maximize production, create fuel-efficient cars, reduce the amount of driving we do and, finally, develop alternatives to fossil fuels. All these efforts deserve increased support. But without a truly new source of fuel, the system will remain in turmoil, prices will soar and the conflict between food and fuel will persist. Senators, my colleagues and I at Sapphire Energy have been thinking about this for a long time. We knew that an energy source based on agriculture would serve this country best as a stepping stone to a green energy future. We knew that energy requiring vast amounts of fresh water resources was not a viable option. And, finally, if we wanted to make a difference quickly, we knew we needed a fuel that could be transported and refined just like petroleum. Two years ago we asked ourselves, "In a perfect world, how should the next generation of fuel be produced and distributed?" These were our founding principles: 1.Fuel production must not use farmland. Period. 2.Fuel production must be carbon neutral. 3.Fuel production and delivery must use the existing petroleum infrastructure. 4.Fuel production must scale domestically to reach tens of billions of gallons per year. 5.The next generation of fuels must be compatible with today's vehicles. That sounded like a tall order. But Americans have dreamed big and delivered in the past - atomic energy, highways and railroads that crisscross our nation, a man on the moon, mapping the human genome. Now, a similar ingenuity has developed a completely renewable and homegrown source of gasoline. I offer that we do not have to sacrifice food production for fuel production. We do not have to choose between powering our industries and feeding the hungry. The Sapphire processes and technologies are so revolutionary that the company is at the forefront of an entirely new industrial category called "Green Crude Production". Products and processes in this category differ significantly from other biofuels because they are made solely from photosynthetic microorganisms, sunlight and CO2; do not result in biodiesel or ethanol; enhance and replace petroleum-based products; are carbon neutral and renewable; and don't require any food crop or agricultural land. The Sapphire process produces a replica of light sweet crude, green crude that can be used in traditional refining to make real gasoline, diesel, and aircraft fuel. Our feedstocks produce 10 to 100 times more energy per acre than cropland biofuels. A side benefit of our process is that the microorganisms consume pollutants and convert them to fuel. Using the Sapphire process, we have dramatically altered the domestic energy and petrochemical landscape and avoided the food versus fuel debate. Please allow me to reiterate, the Sapphire process does not create ethanol; it does not produce biodiesel; it does not use crops or valuable farmland. Sapphire fuel is the fuel we use today, the kind that is in your car or truck or airplane right now. It's gasoline, diesel and aircraft fuel. Senators, this is a solution. This is a truly renewable, truly sustainable, alternative fuel- "Sapphire's green crude oil". This fuel, Sapphire fuel, is the world's first truly renewable petrochemical product, produced by converting sunlight and CO2 into a renewable, carbon-neutral alternative to conventional fossil fuels, without the drawbacks of current biofuels. This fuel is compatible with the current energy infrastructure- cars, refineries, and pipelines. Sapphire's scalable production facilities will produce this fuel economically because production will be modular, transportable, fueled by sunlight, and not constrained by arable land, crops, or other natural resources. Sapphire has turned sunlight into gasoline.

#### Food/fuel link creates unique risks for escalation – food spikes now exacerbates current economic conditions – causes rampant civil conflict \*\*\*gender modified\*\*\*

Manila Times November 5 2008 “Let’s attend to food security”, http://www.manilatimes.net/national/2008/nov/05/yehey/opinion/20081105opi1.html

He tells the world that the economic meltdown now afflicting the globe is gripping (hu)mankind with “the twin crises of finance and food.” The world, he warns, will be “far worse” than the Great Depression of the 1930s, the Black October of 1987 or the Asian Economic Collapse of 1997. That is because the financial crisis is accompanied by “high food prices and food shortages, and the steady erosion of agriculture and rural economies.” He says. “Food availability and affordability are the bedrocks of any society. During the Great Depression, Black October and the Asian Economic Crisis, food prices were at historic lows. No matter how dire the situation, food was still plentiful and cheap. Today, the story is different. “Food is in shorter supply; prices have been steadily climbing since 2001 and have escalated dramatically since 2006. According to the tracking of our Organization, food prices rose by 9 percent in 2006, 24 percent in 2007 and surged 51 percent in the past 12 months. “Although we saw some price drops for certain food commodities in the past months, average prices are still much higher than normal and the international markets remain volatile. During normal times, that level of ‘sticker shock’ would spell hardship for most working people and the poor. Coupled with an economic crisis of the enormity taking place today, the impact could be catastrophic.” Dr. He calls on us to give due importance to food security. “The role of food security in wider events should not be underestimated. Food shortages and runaway food price inflation have a history of leading to social unrest and political upheaval. The current crisis has already sparked riots and social turbulence in over 30 countries and contributed to the fall of at least one elected government.

#### Food riots escalate to global war – ignite all regional hot spots

Bernardo V. Lopez September 10 1998 “Global recession phase two: Catastrophic (Private sector views)”, BusinessWorld

Certainly, global recession will spawn wars of all kinds. Ethnic wars can easily escalate in the grapple for dwindling food stocks as in India-Pakistan-Afghanistan, Yugoslavia, Ethiopia-Eritrea, Indonesia. Regional conflicts in key flashpoints can easily erupt such as in the Middle East, Korea, and Taiwan. In the Philippines, as in some Latin American countries, splintered insurgency forces may take advantage of the economic drought to regroup and reemerge in the countryside. Unemployment worldwide will be in the billions. Famine can be triggered in key Third World nations with India, North Korea, Ethiopia and other African countries as first candidates. Food riots and the breakdown of law and order are possibilities. Global recession will see the deferment of globalization, the shrinking of international trade - especially of high-technology commodities such as in the computer, telecommunications, electronic and automotive industries. There will be a return to basics with food security being a prime concern of all governments, over industrialization and trade expansions. Protectionism will reemerge and trade liberalization will suffer a big setback. The WTO-GATT may have to redefine its provisions to adjust to the changing times. Even the World Bank-IMF consortium will experience continued crisis in dealing with financial hemorrhages. There will not be enough funds to rescue ailing economies. A few will get a windfall from the disaster with the erratic movement in world prices of basic goods. But the majority, especially the small and medium enterprises (SMEs), will suffer serious shrinkage. Mega-mergers and acquisitions will rock the corporate landscape. Capital markets will shrink and credit crisis and spiralling interest rates will spread internationally. And environmental advocacy will be shelved in the name of survival. Domestic markets will flourish but only on basic commodities. The focus of enterprise will shift into basic goods in the medium term. Agrarian economies are at an advantage since they are the food producers. Highly industrialized nations will be more affected by the recession. Technologies will concentrate on servicing domestic markets and the agrarian economy will be the first to regrow. The setback on research and development and high-end technologies will be compensated in its eventual focus on agrarian activity. A return to the rural areas will decongest the big cities and the ensuing real estate glut will send prices tumbling down. Tourism and travel will regress by a decade and airlines worldwide will need rescue. Among the indigenous communities and agrarian peasantry, many will shift back to prehistoric subsistence economy. But there will be a more crowded upland situation as lowlanders seek more lands for production. The current crisis for land of indigenous communities will worsen. Land conflicts will increase with the indigenous communities who have nowhere else to go either being massacred in armed conflicts or dying of starvation. Backyard gardens will be precious and home-based food production will flourish. As unemployment expands, labor will shift to self-reliant microenterprises if the little capital available can be sourced. In the past, the US could afford amnesty for millions of illegal migrants because of its resilient economy. But with unemployment increasing, the US will be forced to clamp down on a reemerging illegal migration which will increase rapidly. Unemployment in the US will be the hardest to cope with since it may have very little capability for subsistence economy and its agrarian base is automated and controlled by a few. The riots and looting of stores in New York City in the late '70s because of a state-wide brownout hint of the type of anarchy in the cities. Such looting in this most affluent nation is not impossible. The weapons industry may also grow rapidly because of the ensuing wars. Arms escalation will have primacy over food production if wars escalate. The US will depend increasingly on weapons exports to nurse its economy back to health. This will further induce wars and conflicts which will aggravate US recession rather than solve it. The US may depend more and more on the use of force and its superiority to get its ways internationally.

## Solvency

### 2nc solvency

#### We solve the entirety of the case through a minor legislative amendment—the current RFS fails to list algae as an incentive-eligible fuel source, which deters investment and widespread commercialization—the plan solves this, leading to an explosion in algae production—it will happen quickly – it solves dependence and warming.

#### Extend the Food/Fuel impact – current RFS creates a food/fuel link which escalates food prices – spikes risk instability in all the globes hot spots – that causes global nuclear war – that’s Lopez

#### RFS causes a direct tradeoff in alternative energy investment

Brent D. Yacobucci (Specialist in Energy and Environmental Policy Resources, Science, and Industry Division) and Randy Schnepf (Specialist in Agricultural Policy Resources, Science, and Industry Division) December 3 2007 CRS Report for Congress, "Selected Issues Related to an Expansion of the Renewable Fuel Standard (RFS)" <http://assets.opencrs.com/rpts/RL34265_20071203.pdf>

Critics of an RFS have taken issue with many specific aspects of biofuel production and use, but a general public policy criticism of the RFS is that, by picking the “winner,” policymakers may exclude or retard the development of other, potentially more preferable alternative energy sources.5 They contend that biofuels are given a huge advantage via billions of dollars of annual subsidies which distort investment markets by redirecting venture capital and other investment dollars away from competing alternative energy sources. Instead, these critics have argued for a more “technology neutral” policy such as a carbon tax, a cap-and-trade system of carbon credits, or a floor price on imported petroleum.

#### Amending the RFS to include algae solves—it will drive investment in algae while undercutting the food/fule link which is driving food prices to all time highs

Energy Washington Week June 18 2008 “Senate Energy Committee Eyes RFS Revisions To Ease Rising Food Prices”

Key members of the Senate Energy & Natural Resources Committee are suggesting changes are needed to the recently enacted renewable fuels standard to allow greater use of non-agriculture-based feedstocks in fuel production in response to rising food prices. The senators say the RFS definition should be expanded to include algae-derived fuels, referred to as "green crude" and other emerging technologies, as well as forestry wastes. The senators' comments are significant because they might indicate a political compromise in the emerging food versus fuel debate, which has prompted some Senate Republican leaders to call for a freeze on the current RFS. But committee senators, both Democrats and Republicans, are suggesting a broadening of the RFS definition could address the issue. At a June 12 committee hearing, a senior DOE official also indicated support for such revisions to the RFS. The current RFS, enacted as part of the 2007 energy law, requires the use of 36 billion gallons of renewable fuels by 2022. At the hearing, Sens. Ron Wyden (D-OR) and Bob Corker (R-TN) both expressed strong support for changes to the RFS. Wyden said a provision that prohibits woody biomass culled from national forest land needs to be re-examined, while Corker said the RFS definition needs to be expanded to include algae-based fuels. Rising global food prices have led some lawmakers to call for the RFS to be dramatically reduced, either permanently or for one year. But committee Chairman Jeff Bingaman (D-NM) appeared reluctant to change the mandate so drastically, saying it would chill investment in a second generation biofuels. Rather than these changes, he suggested that diversifying the feedstocks away from food crops would be a better path. A committee staffer describes the hearing as a "fact-finding" effort which could inform legislative changes to the RFS. An industry source said legislation would likely be introduced next year. "I am concerned that altering that path now would not only be unfair to the industry that is responding to the government policies that have already been put in place, but also would have negative implications for second-generation fuels," Bingaman said at the hearing. "As we diversify away from biofuel feedstocks that compete with our grain supply, we also diversify the geographic production areas beyond the current base in the Midwest." The controversy is prompted in part by last-minute changes made in conference negotiations to last year's energy bill to adopt a House-approved definition for the RFS, which focused on corn-based ethanol and other agriculture-based fuels. Senators now are looking to revise the RFS to reflect the more expansive definition included in the original Senate-passed energy bill. At the Senate energy committee hearing, Jason Pyle, CEO of Sapphire Energy, which produces an algae derived fuel that can be integrated into the current petroleum-based infrastructure, said the fuel his company is producing is not admissible under the current RFS, which should be revised to ensure technological neutrality. "Congress should ensure that the next round of incentives can be applied to advanced technologies such as Sapphire's," he testified. "American innovation is the heart of our people and our economy; I urge you to support this with additional legislation that promotes a technology neutral RFS." Sen. Corker backed that assertion. "I could not agree more and I hope we can work with you and the committee to see that that happens." He said revising the RFS would reduce pressure on agricultural lands to produce fuel. DOE Assistant Secretary for Energy Efficiency and Renewable Energy Alexander Karsner also argued for a more "neutral" approach to the RFS, and said a "consolidated, single point of stimulus that is technology neutral, predictable, long term, and...carbon weighted" is needed. In an apparent effort to add detail to his recommendation, Karsner pointed to the definition of renewable fuels in the Energy Policy Act of 1992 as a model for revising last year's energy law. Sen. Wyden focused his comments on a provision in the current law that excludes biomass culled from federal lands from being used to meet the RFS. "When our country is so concerned about these skyrocketing food prices, we ought to be using as much cellulosic material that we possibly can," he said. "But you can't do that because anything grown on federal land is out for the purpose of defining biomass and the RFS." Karsner agreed, and cited a Georgia facility being built under a DOE cost-share program that has to dramatically increase the distance of its feedstock shipments, and avoid receiving wastes from a nearby federal forest, to ensure its fuel meets the current the RFS. "There is not a good rational reason why we should exclude biomass from federal lands," he said. Joseph Glauber, chief economist at the Department of Agriculture, also argued that the current RFS is flawed. At a February hearing, Bingaman indicated he would support the changes to the RFS, noting the current law appears to "micromanage" the market and may exclude "biocrude from algae." He also said the "definition of 'renewable biomass' from which the required biofuel can be derived is too narrow. Examples of excluded feedstock include woody biomass from hazardous fuels reduction on federal lands, and urban and commercial wood waste."

#### The status quo creates a zero sum policy with algae and biofules – Amending the RFS to be technology neutral solves – breaks the food/fuel links and solves energy dependence

Fred Upton (R-US Congress) John Barrow (D-US Congress) and Mike Doyle (D-US Congress) 5/6/2008 Political/Congressional Transcript Wire, Congressional Quarterly, “rep. rick boucher holds a hearing on the renewable fuels standard”, http://www.alacrastore.com/storecontent/voxantcq/2008tr05060003u94)

UPTON: Well, thank you, and I thank you, my friend, Mr. Chairman, for holding this important and certainly timely hearing. One of the major components of the recently signed Energy Independence and Security Act was an ambitious Renewable Fuels Standard, RFS. I have always been and remain supportive of renewable fuels. However, as we all know, Congress doesn't always get things right. The laws we write are not always perfect and often require reexamination, corrections and oversight. And certainly there are some legitimate concerns with using food for fuel that we need to continue to examine. I believe that the goal of that legislation was to meet the needs of sound energy policy, environmental policy, as well as national security. Many of the provisions in this new energy package that President Bush signed into law, in fact, meet that criteria. Unfortunately, after further examination and recent economic and environmental studies, the RFS may miss the mark in a few areas. For example, if the goal is to increase our usage of renewable fuel, we should examine the impact on cutting the import tariff, which would certainly bring, hopefully, a flood of renewable fuel to the market. I will be asking our witnesses about that proposal. I want to be perfectly clear; I support the use and development of renewable fuels. I introduced a bill in the last Congress and again in January last year, along with Mr. Doyle, that requires all gasoline sold in the U.S. after 2012 to contain a minimum of 10 percent renewable fuel, something that the State of Minnesota already has on the books. We were careful not to specify any one technology or source of fuel, allowing the market to fill the need, be it corn- based ethanol, cellulosic or fuel from algae or other renewable source, perhaps even sugar. The new RFS does not allow our technology-neutral and feedstock- neutral model. I believe that this may be contributing to many of the problems with the RFS. While biofuels, such as ethanol, are not the silver bullet to cut fuel prices or increase supply, they are, in fact, an important part of the overall puzzle, along with conservation, efficient technologies and increasing domestic oil supply through increased production. Under current law, there is no effective safety valve to allow for unforeseen difficulties in meeting the required ethanol volumes that last for more than a year, such as ethanol production shortfalls. Many proposed plants are being canceled or delayed due to the high cost of corn or inconsistent state laws that prevent refiners from meeting the national renewable mandate. For example, the nation's largest gasoline market, California, limits the amount of ethanol in gasoline to 5.7 percent until 2010. And in 2008, the federal requirement translates to 7.7 percent, in '09 about 9 percent. The California deficit would need to be made up in the rest of the country through increased blending, and some refiners cannot easily meet the California deficit with refineries in the rest of the country since EPA regulations and car warranties currently prohibit blending above 10 percent use in conventional autos. Recognizing that problem, I introduced a bill with my good friend Charlie Gonzalez that would provide refiners with more time to meet that biofuel mandate. Our legislation would allow a carryforward of up to three calendar years for refiners to make up deficits in meeting the mandate in '08, '09 and '010. For instance, refiners who do not blend in enough renewable fuel in '08 would have until 2011 to make up that deficit. Current law provides refiners who do not blend in enough renewable fuels a shorter, one-year window to make up that deficit. This bipartisan legislation would help avoid supply shortages and price spikes that might otherwise occur. Now, I'm one that reads and signs all of my legislative mail, all of it. And one of the top issues that our constituents are concerned about is certainly the high cost of gasoline. The price of a barrel of oil is strongly entrenched above $100 -- today the price is over $120 -- with no sign of retreating. Gasoline prices are on a path towards $4 a gallon, yet America's oil resources remain off limits to exploration. According to the federal government estimates, there is enough oil in deep waters many miles off our coasts and on federal lands to power more than 60 million cars for 60 years. Additionally, if we advance the commercialization of the nation's two-trillion-barrel shale oil resource, we will meet the U.S. oil needs for over two centuries. It would be ideal if we could grow all of our own fuel; however this is not a possibility. And if we overreach, we will be creating even more problems. Along with a strong RFS, if we were permitted to utilize our vast domestic energy resources, prices would fall, and the U.S. would achieve a greater level of energy security. Inexpensive energy helped build our economy into the most powerful and prosperous in the world. And high energy costs obviously take us in the opposite direction. We can all talk about alternative energy. Well, the alternative to our existing policy is to achieve lower prices, along with energy security, by relying on environmentally friendly American energy. American energy includes renewable fuels, coal-to-liquids, oil shale and the vast reserves of domestic oil and natural gas that are being blocked by shortsighted policy. We owe it to the working families to pursue an energy policy with a vision of the future. We cannot stand idly by for another year and allow gas to go up to even perhaps $5 a gallon. And at this point, I would like unanimous consent to put a letter in from API, which I have somewhere in my notes. And with that, Mr. Chairman, I yield back my time. Thank you. BOUCHER: Without objection that letter will be made a part of the record. The chair recognizes the gentleman from Georgia, Mr. Barrow, for three minutes. BARROW: I thank the chair. At the outset, I want to commend Ms. Herseth Sandlin for her bill and her legislation, which I think tries to strike the right balance here. I agree with her that we need to sort of widen the definition of what wood waste can be for an effective advanced biofuels policy. But at the same time, I want to make sure that we don't loosen it so much that we end up deranging the market for other products. I have a huge stake in this myself. In my district, in Treutlen County, Georgia, Range Fuels is building the first commercially viable, commercial-scale cellulosic ethanol plant in the country. And it's our plan to try and provide added value of the stuff that has no value right now. And I've advocated very strongly for a substantial grant from the Industry Department to try and jump-start that operation there. And the vision that we have is that things that have no value right now can be better put to advanced biofuels development than stuff that has existing value. And that's a concern I've got because I've also got a stake in this because I sat in the same room with folks in my party,and the leadership of my party are writing checks on Georgia's supply of biomass that we just can't cash in our state. I've sat around with folks and they've said we've got enough biomass in Georgia to do this, do that. We got a lot of other things going on with Georgia biomass right now with the pulp industry and the construction industry. We got a lot of uses for the stuff that we're doing right now in Georgia. You know, we talk about not wanting to pick winners and losers and not try and play favorites with the programs that we initiate. And we adopt programs that ostensibly look neutral in their impact and will rely upon the invisible hand of the marketplace to sort of guide our choices. But if existing technology can only meet a certain mandate in a certain way and incentives geared toward providing that we do it by way of existing technology, we'll find out that the invisible hand is a very heavy hand, and it can derange a lot of existing markets. But what I think we ought to be doing -- I can't help but relate to this problem in terms of my own experience as a local elected official. Perhaps we ought to be thinking about this a little bit more of the way county commissioners or city councilman think about zoning decisions, because it's a zero-sum game, though. You change the zoning of a piece of land, and it ain't making any more land. You change the zoning, and you're reducing the supply of land that can be used one way, and you're increasing the supply of the land to be used in another way -- zero-sum game. And we ought to be thinking about what we're doing with our energy feedstocks the way city councilman and county commissioners have to think about zoning decisions. What's the highest and best use of this energy feedstock over here, and what's the highest and best use of that energy feedstock over there? And let's don't pretend we're being neutral when actually we're setting things up. Our ostensibly neutral fashion is actually going to take all of the feedstocks being used for one purpose and apply it toward another. So if we can think about that, I think that'll -- it's certainly guiding my thinking of this. And I'm interested in hearing what the witnesses have to say about how we can make more effective decisions to take advantage of the marketplace in a neutral -- in effect as well as in purpose. Thank you, Mr. Chairman. I yield back the balance of my time. BOUCHER: Thank you, Mr. Barrow. The gentleman from Kentucky, Mr. Whitfield, is recognized for three minutes. WHITFIELD: Mr. Chairman, thank you very much, and we genuinely appreciate your holding this hearing this morning on a topic of great importance for the entire country. I might say that recently I met with a group of agriculture leaders, and they made the comment that the nation's energy policy, particularly referring to this mandate on ethanol production, has more of an impact on agriculture than the agricultural policy. So I think it's imperative that we move deliberately and cautiously in trying to reverse a policy until we understand completely the ramifications on it as it relates to agriculture prices, as it relates to oil prices. And so I want to commend the chairman for the hearing. We look forward to some of our witnesses today who have some expertise in this area to help us move forward in a way that is most likely to be correct for our country. And I yield back my time. BOUCHER: Thank you very much, Mr. Whitfield. The gentleman from Pennsylvania, Mr. Doyle, is recognized for three minutes. DOYLE: Thank you, Mr. Chairman. Mr. Chairman, it sometimes happens that we here in Congress pass policies that don't turn out as good in the real world as they looked on the drafting paper. And despite our best intentions and due diligence, the law of unintended consequences rears its ugly head, forcing us to revisit our earlier policy decisions. That's what I believe is happening today in regard to corn-based ethanol. And I commend you, Mr. Chairman, for holding this hearing so that we can again look at the Renewable Fuels Standard so that we can ensure that we get the results we seek without causing more problems in the future. I remember back when we passed the ethanol mandates back in the Energy Policy Act. Corn ethanol was presented almost as a Holy Grail solution to the challenges presented by our dependence on foreign oil. It seemed at the time that we could not only start to break the chains of this dependence but we could do it in a way that would benefit the American farmer and put us on a path to combating global warming. While time has proven that some benefits have resulted in this policy, most notably the increased profits in the agricultural sector, I believe its negatives today far outweighs its benefits. I've said time and time again that there's no silver bullet to address the dual challenges of energy independence and global warming. There's no one policy we can adopt or one technology we can develop to meet these challenges. Unfortunately, our committee and our Congress essentially chose food-based ethanol and encouraged the private sector through authorizations in the tax code to pick this biofuel over others. We must learn from this mistake and roll back these policies. Now don't get me wrong; I'm not advocating for a roll back of the entire Renewable Fuels Standard, as I believe the standard itself can help move us towards energy independence. What I am advocating is that we roll back the support structure that food-based ethanol receives and which other promising biofuels are not. We need to encourage all of these advances, not pick the one we can sell better at home. Food prices are rising, rainforests are being deforested, and we need to understand the real-world realities that this policy has caused. Any food that is used for fuel is a food that won't be used to feed our nation and to a large extent the world. We have other options, such as algae, municipal waste and the like, which offer a path towards energy independence that don't put the burden on the backs of the hungry to pay for it or pay for it by destroying rainforests. In conclusion, Mr. Chairman, we need to revisit this policy and back away from food-to-fuel policies and instead accelerate the development of biofuels that don't put our energy needs ahead of the needs of the hungry or the environment. With that, Mr. Chairman, I yield back the balance of my time.

### Algae solves – Warming

#### Algae solves warming—it removes co2 from the atmosphere

AFP July 10 2008 “As planet swelters, are algae unlikely saviour?”, <http://afp.google.com/article/ALeqM5ir4Mg2eQ23RPDhBkH2BnulZai-ZA>

As the world mulls over the conundrum of how to satisfy a seemingly endless appetite for energy and still slash greenhouse gas emissions, researchers have stumbled upon an unexpected hero: algae. So-called microalgae hold enormous potential when it comes to reining in both climate change, since they naturally absorb large amounts of carbon dioxide, as well as energy production, since they can easily be converted to a range of different fuel types. "This is certainly one of the most promising and revolutionary leads in the fight against climate change and the quest to satisfy energy needs," Frederic Hauge, who heads up the Norwegian environmental group Bellona, told AFP. The idea is to divert exhaust spewed from carbon burning plants and other factories into so-called "photobioreactors", or large transparent tubes filled with algae. When the gas is mixed with water and injected into the tubes, the algae soak up much of the carbon dioxide, or CO2, in accordance with the principle of photosynthesis. The pioneering technique, called solar biofuels, is one of a panoply of novel methods aiming to crack the problem of providing energy but without the carbon pollution of costly fossil fuels -- with oil pushing 140 dollars a barrel and supplies dwindling -- or the waste and danger of nuclear power. Studies are underway worldwide, from academia in Australia, Germany and the US, to the US Department of Energy, oil giant Royal Dutch Shell and US aircraft maker Boeing. This week alone, Japanese auto parts maker Denso Corp., a key supplier to the Toyota group, said it too would start investigating, to see if algae could absorb CO2 from its factories. The prestigious Massachusetts Institute of Technology (MIT), for one, has successfully tested the system, finding that once filtered through the algae broth, fumes from a cogeneration plant came out 50-85 percent lighter on CO2 and contained 85 percent less of another potent greenhouse gas, nitrogen oxide. Once the microalgae are removed from the tubes they can easily be buried or injected into the seabed, and thus hold captive the climate changing gases they ingest indefinitely. And when algae grown out in the open are used in biomass plants, the method can actually produce "carbon negative" energy, meaning the energy production actually drains CO2 from the atmosphere. This is possible since the microalgae first absorbs CO2 as it grows and, although the gas is released again when the biomass burns, the capturing system keeps it from re-entering the air. "Whether you are watching TV, vacuuming the house, or driving your electric car to visit friends and family, you would be removing CO2 from the atmosphere," Hauge said. Instead of being stored away, the algae can also be crushed and used as feedstock for biodiesel fuel -- something that could help the airline industry among others to improve its environmental credentials. In fact, even the algae residue remaining after the plants are pressed into biodiesel could be put to good use as mineral-rich fertiliser, Hauge said "You kill three birds with one stone. The algae serves at once to filter out CO2 at industrial sites, to produce energy and for agriculture," he pointed out. Compared with the increasingly controversial first-generation biofuels made from food crops like sunflowers, rapeseed, wheat and corn, microalgae have the huge advantage of not encroaching on agricultural land or affecting farm prices, and can be grown whenever there's sunlight. They also can yield far more oil than other oleaginous plants grown on land. "To cover US fuel needs with biodiesel extracted from the most efficient terrestrial plant, palm oil, it would be necessary to use 48 percent of the country's farmland," according to a recent study by the Oslo-based Centre for International Climate and Environmental Research. "The United States could potentially replace all of its petrol-based automobile fuel by farming microalgae on a surface corresponding to five percent of the country's farmland," the study added.

#### Using algae will end our dependence on fossil fuel and removes co2 from the atmosphere—solves global warming

National Renewable Energy Laboratory, 98 (“A Look Back at the U.S. Department of Energy’s Aquatic Species Program: Biodiesel from Algae” <http://www1.eere.energy.gov/biomass/pdfs/biodiesel_from_algae.pdf>)

CO2 is recognized as the most important (at least in quantity) of the atmospheric pollutants that contribute to the “greenhouse effect,” a term coined by the French mathematician Fourier in the mid-1800s to describe the trapping of heat in the Earth’s atmosphere by gases capable of absorbing radiation. By the end of the last century, scientists were already speculating on the potential impacts of anthropogenic CO2. The watershed event that brought the question of global warming to the forefront in the scientific community was the publication of Revelle’s data in 1957, which quantified the geologically unprecedented build-up of atmospheric CO2 that began with the advent of the industrial revolution. Revelle14 characterized the potential risk of global climate change this way: “Human beings are carrying out a large scale geophysical experiment of a kind that could not have happened in the past nor be produced in the future. Within a few centuries, we are returning to the atmosphere and the oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years.” Despite 40 years of research since Revelle first identified the potential risk of global warming, the debate over the real impacts of the increased CO2 levels still rages. We may never be able to scientifically predict the climatic effects of increasing carbon dioxide levels due to the complexity of atmospheric and meteorological modeling. Indeed, Revelle’s concise statement of the risks at play in global climate change remains the best framing of the issue available for policy makers today. The question we face as a nation is how much risk we are willing to take on an issue like this. That debate has never properly taken place with the American public. As Revelle’s statement implies, the burning of fossil fuels is the major source of the current build up of atmospheric CO2. Thus, identifying alternatives to fossil fuels must be a key strategy in reducing greenhouse gas emissions. While no one single fuel can substitute for fossil fuels in an all of the energy sectors, we believe that biodiesel made from algal oils is a fuel which can make a major contribution to the reduction of CO2 generated by power plants and commercial diesel engines. The Synergy of Coal and Microalgae Many of our fossil fuel reserves, but especially coal, are going to play significant roles for years to come. On a worldwide basis, coal is, by far, the largest fossil energy resource available. About one-fourth of the world’s coal reserves reside in the United States. To put this in perspective, consider the fact that, at current rates of consumption, coal reserves could last for over 200 years. Regardless of how much faith you put in future fossil energy projections, it is clear that coal will continue to play an important role in our energy future—especially given the relatively large amounts of coal that we control within our own borders. DOE’s Energy Information Administration estimates that electricity will become an increasingly large contributor to future U.S. energy demand. How will this new demand be met? Initially, low cost natural gas will grow in use. Inevitably, the demand for electricity will have to be met by coal. Coal will remain the mainstay of U.S. baseline electricity generation, accounting for half of electricity generation by the year 2010. The long term demand for coal brings with it a demand for technologies that can mitigate the environmental problems associated with coal. While control technologies will be used to reduce air pollutants associated with acid rain, no technologies exist today which address the problem of greenhouse gas emissions. Coal is the most carbon-intensive of the fossil fuels. In other words, for every Btu of energy liberated by combustion, coal emits more CO2 than either petroleum or natural gas. As pressure to reduce carbon emissions grows, this will become an increasingly acute problem for the U.S. One measure of how serious this problem could be is the absurdity of some of the proposals being developed for handling carbon emissions from power plants. The preferred option offered by researchers at MIT is ocean disposal, despite the expense and uncertainty of piping CO2 from power plants and injecting the CO2 in the ocean15. Commonsense suggests that recycling of carbon would be more efficacious than deep ocean disposal. No one clearly understands the long-term effects of injecting large amounts of CO2 into our oceans. Beyond these environmental concerns, such largescale disposal schemes represent an economic sinkhole. Huge amounts of capital and operating dollars would be spent simply to dispose of carbon. While such Draconian measures may ultimately be needed, it makes more sense to first re-use stationary sources of carbon as much as possible. Algae technology is unique in its ability to produce a useful, high-volume product from waste CO2. Consumption of coal, an abundant domestic fuel source for electricity generation, will continue to grow over the coming decades, both in the U.S. and abroad. Algae technology can extend the useful energy we get from coal combustion and reduce carbon emissions by recycling waste CO2 from power plants into clean-burning biodiesel. When compared to the extreme measures proposed for disposing of power plant carbon emissions, algal recycling of carbon simply makes sense.

#### Greenhouse Gasses Are Absorbed By Algae As Fertilizer – Solving Warming

Carlsen December 27 2006 (biodiesel expert for Greaseworks.org, “[Want alternative energy? Try pond scum](http://www.greaseworks.org/modules.php?op=modload&name=News&file=article&sid=308&mode=thread&order=0&thold=0),” <http://www.greaseworks.org/modules.php?op=modload&name=News&file=article&sid=308&mode=thread&order=0&thold=0> //

That's where alternative energy promoters and their ecology movement allies find common cause. It turns out the best sources of fertilizer for growing algae are the very greenhouse gases of carbon dioxide, methane, nitrous oxide and ozone that electrical power generators are under increasing pressure to reduce and the animal wastes that are increasingly becoming a problem for industrial-scale livestock operations. A handful of start-up companies and countless academic programs are exploring ways to divert gases linked to global warming or animal wastes into systems for growing algae, which can then be processed into ethanol and biodiesel.

### Algae solves – dependence

#### Algae can solve oil dependence – viability depends on market conditions

Amanda Leigh Haag March 29 2007, “Pond-Powered Biofuels: Turning Algae into America’s New Energy,” Popular Mechanics, www.popularmechanics.com/science/earth/4213775.html

Given the right conditions, algae can double its volume overnight. Unlike other biofuel feedstocks, such as soy or corn, it can be harvested day after day. Up to 50 percent of an alga’s body weight is comprised of oil, whereas oil-palm trees—currently the largest producer of oil to make biofuels—yield just about 20 percent of their weight in oil. Across the board, yields are already impressive: Soy produces some 50 gallons of oil per acre per year; canola, 150 gallons; and palm, 650 gallons. But algae is expected to produce 10,000 gallons per acre per year, and eventually even more. “If we were to replace all of the diesel that we use in the United States" with an algae derivative, says Solix CEO Douglas Henston, "we could do it on an area of land that’s about one-half of 1 percent of the current farm land that we use now." Solix plans to complete its second prototype by the end of April and to begin building a pilot plant this fall. That plant will take advantage of CO2 generated from the fermentation and boiler processes of New Belgium Brewery, also in Fort Collins. The company’s initial target is to be competitive with biodiesel, which historically sells for about $2 per gallon, wholesale. They believe they can reach this goal within a few years, and are ultimately aiming to compete with petroleum. John Sheehan, an energy analyst with the National Renewable Energy Laboratory (NREL) in Golden, Colo., believes these goals are within reach. “There is no other resource that comes even close in magnitude to the potential for making oil,” says Sheehan, who worked in the lab’s algae program before it was shut down by the Department of Energy. One of algae’s great strengths, Sheehan adds, is its ability to grow well in brackish water. In the desert southwest, where much of the groundwater is saline and unsuitable for other forms of agriculture, algae can proliferate. GreenFuel Technologies Corp., based in Cambridge, Mass., is focused on cultivating algae that can produce high yields of both biodiesel and ethanol. There are more than 100,000 strains of algae, with differing ratios of three main types of molecule: oils, carbohydrates and protein. Strains of algae high in carbohydrates as well as oils produce starches that can be separated and fermented into ethanol; the remaining proteins can be turned into animal grains. GreenFuel hopes its pilot plant will see initial yields of 8000 gallons of biodiesel and 5000 gallons of ethanol per acre of algae. The main focus now, says Cary Bullock, GreenFuel’s president and CEO, is figuring out “how to grow algae fast enough and cheap enough that it makes sense economically. That’s not easy to do.” With the science well in hand, the degree to which algae-based biofuels can replace petroleum—or the limited acreage of traditional feedstocks—rests upon that bottom line. Once the technology hits the ground, will a commercial-scale facility be on par with petroleum? Says Bullock: “You don’t know until you’ve actually built the thing.”

### Algae solves – land use

#### Algae solves warming, land conversion problems

Timoty Gardner June 11 2008 “Algenol Trains Algae to Turn Carbon into Ethanol,” Reuters, www.reuters.com/articlePrint?articleId=USN1032368520080611

And algae's carbon-absorbing potential could be an advantage. Each 100 million gallons of ethanol from algae will absorb about 1.5 million tonnes of carbon dioxide, the company said. That gives Woods confidence that algae-to-ethanol is better emissions reduction technique than capturing the gas at power plants and socking it away underground. As a former natural gas company executive, he said he does not put faith in storing any gas underground permanently. Another advantage of ethanol from algae, NRDC's Steelman said, is its sheer productivity compared to agricultural crops. Algenol estimates it can make 6,000 gallons of ethanol from an acre of land. At that rate, Steelman said, if all U.S. ethanol was made from algae it would only use 3 percent of the land that corn needs to make the fuel. "It's a huge advantage," he said.

### Algae solves – Phosphorus

#### The plan solves—algae uses waste-water streams as a food source, and produces nitrogen and phosphorus that can be used as fertilizer

Michael Briggs (University of New Hampshire Biodiesel Group) 2004 “Widescale Biodiesel Production from Algae,” <http://www.energybulletin.net/node/2364>

The algae farms would not all need to be built in the same location, of course (and should not for a variety of reasons). The case mentioned above of building it all in the Sonora desert is purely a hypothetical example to illustrate the amount of land required. It would be preferable to spread the algae production around the country, to lessen the cost and energy used in transporting the feedstocks. Algae farms could also be constructed to use waste streams (either human waste or animal waste from animal farms) as a food source, which would provide a beautiful way of spreading algae production around the country. Nutrients can also be extracted from the algae for the production of a fertilizer high in nitrogen and phosphorous. By using waste streams (agricultural, farm animal waste, and human sewage) as the nutrient source, these farms essentially also provide a means of recycling nutrients from fertilizer to food to waste and back to fertilizer. Extracting the nutrients from algae provides a far safer and cleaner method of doing this than spreading manure or wastewater treatment plant "bio-solids" on farmland.

#### Algae can eat wastewater—recycles phosphorus

Virginian-Pilot 1/19/2008 “Learning what goo can do”

In this era of clean and renewable energy development, researchers at other universities are conducting similar experiments with algae and biofuels. But ODU is on a slightly different and potentially important path, using municipal sewage to generate its slimy fuel supply. Their first experiment is being conducted atop a sewage treatment plant run by the Hampton Roads Sanitation District, next door to ODU. The timing could not be better. Virginia, like its neighboring states, is under pressure to reduce nutrient pollution now choking the Chesapeake Bay, and much of the excessive nitrogen and phosphorus comes from sources that include factories, slaughterhouses and sewage plants. So, conceivably, the ODU technology could kill several birds with one stone. Nutrient-rich wastewater from agriculture, industry and municipal sewage could be piped to and purged at algae-growing stations. Biofuels could be produced. And less nitrogen and phosphorus would enter the Bay.

#### Algae Solves Phosphorus Depletion

Mark Jenner (biomass energy consultant and owner of Biomass Rules) 2008 “Algae - The Wonder Crop Of Tomorrow?,” <http://www.highbeam.com/doc/1P3-1504108061.html>

Biomass Energy Outlook THERE are no silver bullet solutions to cheap energy, but algae could come close. Algae has the capacity to remediate carbon dioxide (CO2) emissions, produce energy, generate a source of protein for animal feed and even provide dietary and medicinal supplements for humans. Algae technology developers are racing toward commercial production of algae based on decades of existing research, such as from the Department of Energy (DOE). In nature, algal blooms and red tides generally indicate unnatural nutrientladen waters. These unintended eruptions out-compete the steady-state aquatic life and take over. The new cultivated algae take advantage of the rapid growth attributes of "wild, freerange" algae and reduce the human carbon footprint at the same time. INTENSIVE PRODUCTION The science of intensive algae production is tied to the basic photosynthesis relationship. Green plants convert CO2 and water into sugar (carbohydrates) and oxygen. In this relationship the three limiting factors are CO2, water and solar energy. The most limiting factor will restrict the yield. As solar energy and the CO2 concentration increase, carbohydrate production also increases. While nitrogen (N) and phosphorus (P) also can be limiting nutrients in crop production, they fuel algae growth. (This is why algal blooms grow so fast in nature.) Cultivating algae to remediate water quality problems related to N and P, and at the same time remediate CO2 emissions, is a winning proposition. The project only needs a good supply of solar energy and the facilities to extract the oil and protein from the algae.

### Algae solves – Pollution

#### The Chemical Industry is Failing Now Due to Unsustainable Practices and High Costs from Non-Renewable Energy – A Transition to Algae-Based Renewable Energy is Necessary to Transition the Industry from the Use of Pesticides, Environmental Destruction, Toxic Waste and Mass Amounts of Pollution

Maria Gavrilescu and Yusuf Chisti (Department of Environmental Engineering and Management, Faculty of Industrial Chemistry, Technical, University of Technology and Engineering, Massey University) 2005 “Biotechnology—a sustainable alternative for chemical industry,” Biotechnology Advances 23

The global chemical industry has contributed immensely to achieving the present quality of life, but is under increasing pressure to change current working practices in favor of greener alternatives (Ulrich et al., 2000; Matlack, 2001; Carpenter et al., 2002; Poliakoff et al., 2002; Sherman, 2004; Asano et al., 2004). Concerns associated with chemical industry include its excessive reliance on nonrenewable energy and resources; environmentally damaging production processes that can be unsafe and produce toxic products and waste; products that are not readily recyclable and degradable after their useful life; and excessive regional concentration of production so that social benefits of production are less widely available. Chemical industry is large. The world’s chemicals production in 2002 was in excess of 1.3 trillion. This industry consists of four major subsectors: basic chemicals, specialty chemicals, consumer care products, and life science products. Biotechnology impacts all these sectors, but to different degrees. Demarcation between sectors is not clearcut. General characteristics of these sectors are outlined in the following sections (OECD, 2001b). Basic chemicals or commodity chemicals represent a mature market. Most of the top 50 products by volume of production in this category in 1977 were still among the top 50 in 1993. During this period, the relative ranking by production volume of the products in this category remained largely unchanged (Wittcoff and Reuben, 1996). The basic chemical industry is characterized by large plants that operate using continuous processes, high energy input, and low profit margins. The industry is highly cyclical because of fluctuations in capacity utilization and feedstock prices. The products of the industry are generally used in processing applications (e.g. pulp and paper, oil refining, metals recovery) and as raw materials for producing other basic chemicals, specialty chemicals, and consumer products, including manufactured goods (textiles, automobiles, etc.) (Swift, 1999). Specialty chemicals are derived from basic chemicals but are more technologically advanced and used in lesser volumes than the basic chemicals. Examples of specialty chemicals include adhesives and sealants, catalysts, coatings, and plastic additives. Specialty chemicals command higher profit margins and have less cyclic demand than basic chemicals. Specialty chemicals have a higher value-added component because they are not easily duplicated by other producers or are protected from competition by patents. Consumer care products include soaps, detergents, bleaches, laundry aids, hair care products, skin care products, fragrances, etc., and are one of the oldest segments of the chemicals business. These formulated products are generally based on simple chemistry but feature a high degree of differentiation along brand lines. Increasingly, products in this category are high-tech in nature and developing them demands expensive research. Life science products. These include pharmaceuticals, products for crop protection and products of modern biotechnology. Batch production methods are generally used in making these products. The sector is one of the most research intensive and relies on advanced technology. 3.2. The applications of biotechnology in the chemical industry 3.2.1. Commodity chemicals At the basic level, life processes are chemical processes and understanding their chemistry provides a basis for devising manufacturing operations that approach nature’s elegance and efficiency. Biotechnology uses the power of life to enable effective, rapid, safe and environmentally acceptable production of goods and services. The chemical industry has used traditional biotechnological processes (e.g. microbial production of enzymes, antibiotics, amino acids, ethanol, vitamins; enzyme catalysis) for many years (Moo-Young, 1984; Poppe and Novak, 1992; Rehm et al., 1993; Chisti, 1999; Flickinger and Drew, 1999; Herfried, 2000; Demain, 2000; Spier, 2000; Schmid, 2003). In addition, traditional biotechnology is widely used in producing fermented foods and treating waste (Nout, 1992; Moo-Young and Chisti, 1994; Jo¨ rdening and Winter, 2004). Advances in genetic engineering and other biotechnologies have greatly expanded the application potential of biotechnology and overcome many of the limitations of biocatalysts of the preGMO era (Ranganathan, 1976; Liese et al., 2000; Schu¨ gerl and Bellqardt, 2000). Chemical companies such as Monsanto and DuPont that were once associated exclusively with traditional petrochemical based production methods have either moved exclusively to biotechnology-based production, or are deriving significant proportions of their income through biotechnology (Scheper, 1999; Bommarius, 2004). Important commodity chemicals such as ethanol and cellulose esters are already sourced from renewable agricultural feedstocks in the United States. New processes and renewable resources for other commodity chemicals that are currently derived almost exclusively from petrochemical feedstocks are in advanced stages of development. Examples of these chemicals include succinic acid and ethylene glycol. By the early 1990s biotechnology used for cleaner production was already contributing about 60% of total biotechnology-related sales value for fine chemicals and between 5% and 11% for pharmaceuticals (OECD, 1989). Some fine chemicals being manufactured in multi-tonnage quantities using biotechnology are listed in Table 1 (Bruggink, 1996; Eriksson, 1997). Nearly all these products have been around for a long time, but many are now made using engineered biocatalysts. Two major areas of biotechnology that are driving transformation of the conventional chemical industry are biocatalysis and metabolic engineering (Poppe and Novak, 1992; Kim et al., 2000). Genetic engineering and molecular biology techniques have been used to obtain many modified enzymes with enhanced properties compared to their natural counterparts. Metabolic engineering, or molecular level manipulation of metabolic pathways in whole or part, is providing microorganisms and transgenic crops and animals with new and enhanced capabilities for producing chemicals. A future bioethanol based chemical industry, for example, will rely on biotechnology in all of the following ways: (1) generation of high yield transgenic corn varieties having starch that is readily accessible for enzymatic hydrolysis to glucose; (2) production of engineered enzymes for greatly improved bioconversion of starch to sugars; (3) genetically enhanced ethanol tolerant microorganisms that can rapidly ferment sugars to ethanol; (4) ability to recover ethanol using high-efficiency low-expense bioprocessing. 3.2.2. Specialty and life science products Biotechnology’s role in production of commodity chemicals is significant, but not as visible as its role in production of agrochemicals and fine chemicals (Hsu, 2004). Many renewable bioresources remain to be used effectively because they have been barely studied. Flora and fauna of many of the world’s ecosystems have been barely investigated for existence of novel compounds of potential value. For example, microalgae contribute substantially to primary photosynthetic productivity on Earth, but are barely used commercially. Microalgae are a source or potential source of high-value products such as polyunsaturated fatty acids, natural colorants, biopolymers, and therapeutics (Borowitzka, 1999; Cohen, 1999; Belarbi et al., 2000; Lorenz and Cysewski, 2000; Banerjee et al., 2002; Miro´n et al., 2002; Lebeau and Robert, 2003a, b; Lopez et al., 2004; Leo´n-Ban˜ ares et al., 2004). Microalgae are used to some extent in biotreatment of wastewaters, as aquaculture feeds, biofertilizers and soil inoculants. Potentially, they can be used for removing excess carbon dioxide from the environment (Go`dia et al., 2002). Other microalgae are regarded as potential sources of renewable fuels because of their ability to produce large amounts of hydrocarbons and generate hydrogen from water (Nandi and Sengupta, 1998; Banerjee et al., 2002). Depending on the strain and growth conditions, up to 75% of algal dry mass can be hydrocarbons. The chemical nature of hydrocarbons varies with the producer strain and these compounds can be used as chemical precursors (Dennis and Kolattukudy, 1991; Banerjee et al., 2002). Some microalgae can be grown heterotrophically on organic substrates without light to produce various products (Wen and Chen, 2003).

## Impacts – food/fuel – food prices

### Food prices 2nc

#### Status quo RFS provides incentives for biofuel production which fuels commodity price surges and inflation, that risks global economic meltdown

Larry Elliott, journalist, “Soft landings and hard realities: The IMF thinks we can ride out this crisis, but there could be far worse news to come,” Guardian Weekly, April 18, 2008, lexis, accessed 6/18/2008.

The first is that it is far too early to say that the worst is over. Henry Paulson, who does Summers's old job at the US treasury, said he expected to see some impact from lower interest rates and tax cuts by the third quarter of this year. But that depends on the US housing market stabilising, because until it does there is a real risk of a vicious circle of foreclosures, collapsing consumer confidence, rising unemployment, bigger losses for US banks, tighter credit conditions and a falling stock market. The IMF says that risks are still heavily weighted to the downside. It produced an alternative scenario in which there would be a further tightening of credit conditions, a far bigger drop in equity and property prices than it currently expects, a gloomier assessment of the prospects for long-term productivity growth in the US, and an unwillingness on the part of foreign investors to continue buying US assets. It already believes there is a 25% risk of a global recession; under this alternative scenario it says there would be a deeper and longer period of falling growth in the US, accompanied by an extended period of weakness in the eurozone and spillover effects on the rest of the global economy through weaker trade flows and tougher credit conditions. This scenario looks just as realistic as the fund's baseline soft-landing forecast. For one thing, there is a clear disjunction between the idea that this is the biggest financial shock since the Depression and the idea that there will be only a short-lived and relatively mild impact on growth. In addition, the soft-landing thesis conveniently ignores the other headwinds facing the global economy. These include rocketing commodity prices that are contributing to a sharp rise in imported inflation, severe downward pressure on the dollar that threatens to become a disorderly plunge, the still-sizeable global imbalances that have resulted in massive trade surpluses in Asia, and massive trade deficits in the US, which have been only slightly reduced by a cheaper greenback and weaker growth. That list was supplemented last week by global hunger caused by rising food prices. The world has suddenly woken up to what should have been blindingly obvious: trying to solve the problem of climate change by using crops for biofuel was a short-term fix with potentially lethal result. If you encourage farmers to use land that would have produced food for fuel, the price of food will go up**.** Gordon Brown considers this to be a serious crisis and is right to call for a global response. Yet apart from the humanitarian need to help those going hungry, rising food prices make it harder to avoid recessionin the West, since they stifle consumer confidence and make policy-makers warier about cutting interest rates.

#### US Biofuel policy depletes food stock-piles- causing global food inflation and risking catastrophic price spikes.

Fiona Gartland September 13 2008 “Link between biofuels and rising global food prices highlighted,” The Irish Times, lexis.

ONE OF the key contributors to increased global food prices is the transfer of land from food to biofuel crops, an agricultural conference in Galway was told yesterday. Prof Bob Young, chief economist with the American Farm Bureau in Washington, saida reduction in the amount of land used forthe production ofbiofuels could significantly alter the upward trend in world food prices. He told the Agricultural Science Association national conference that escalating food prices and concerns about the real impact of biofuel production on global warming could lead to a change in policy. The US has set a target of 15 billion gallons of biofuel in 2015. It would take 30 million acres (12 million hectares) of maize, one-third of the US maize area, to achieve this target, Mr Young said. While the Democrats are committed to retaining the current biofuel target, the Republicans are seeking its removal. He said the shift to biofuels, combined with the weak dollar and strong export demand for meat and dairy products, has resulted in a phenomenal increase in prices for US farm products during the past two years. But increased production costs had resulted in the income increase being taken away. Jeff Grant, former chairman of agricultural promoters Meat and Wool New Zealand, told the conference that increasing world population, high energy costs and growth in the major economies of Asia and South America all point to a continuation of food inflation. He said world food stocksare now at their lowest level, lower than at any period in the last half-century. After the second World War, there was one year s supply of food in stock, he said. Stocks had reduced to 133 days supply in 2003 and at the end of last year, stocks had more than halved, to just 57 days. Land availability is a critical issue in food production.

#### Inflationary spiral will cause utter economic and social collapse.

Al Martin June 3 2005 “Renowned Funds Manager Julian Robertson, Predicts Global Economic Collapse,” Global Econ News Article, 6-3-05, <http://newsgroups.derkeiler.com/Archive/Soc/soc.culture.malaysia/2005-07/msg00182.html>

Julian Robertson formerly ran Tiger Management, the world\\'s largest hedge fund. Martin describes Julian Robertson as "One of the greatest of the old-timers. 53 years on the Street. He manages the Robertson group of funds. They used to call him, still do call him ***`***Never Been Wrong' Robertson. Hehas predicted every economic cycle***,*** every debacle, every bull market, and every bear market." Martin says "Of course, he's a very old man now. But his reputation on the Street is like nothing you could imagine. When the segment of his interview was through, his comments alone took the Dow Jones down 50 points. Just on his comments alone. That's how powerful this man’s reputation is." Robertson said that he's worried about the speculative bubble in housing and the fact that more than 1/4 of all consumer spending is now sustained by that bubble, plus the fact that 20 million citizens could lose their homes in a collapse of the speculative bubble in housing, and that the Fed and, indeed, central banks worldwide would act in concert out of desperation to reinflate the global economy in the process,creating an inflationary spiral unheralded in the economic history of the planet. "Where does it end?" Robertson was asked and he said, "Utter global collapse." Not simply economic collapse; complete disintegration of all infrastructure and of all public structures of governments. Utter, utter collapse. That the end is collapse of simply epic proportion. In 10 years time, he said, whoever is still alive on the planet will be effectively starting again."

#### 1.2 billion at risk

California Chronicle January 2 2009 “Bad Economics”, http://www.californiachronicle.com/articles/printFriendly/86593

In the US, farmers have massively shifted their cultivation towards bio-fuel feed stocks, especially maize, often at the expense of soybean and wheat cultivation. About 30 percent of US maize production will go into ethanol in 2008 rather than into world food and feed markets. High energy prices have also made agricultural production more expensive by raising the cost of mechanical cultivation, inputs like fertilisers and pesticides, and transportation of inputs and outputs. At the same time, the growing world population is demanding more and different kinds of food. Rapid economic growth in many developing countries has pushed up consumers´ purchasing power, generated rising demand for food, and shifted food demand away from traditional staples and toward higher-value foods like meat and milk. This dietary shift is leading to an increased demand for grains used to feed livestock. It is more important to let the developed country farmers decide on what they will plant, based on the relative prices and on the international prices, but not subsidised prices. The hardest hit by the rising food prices in Asia Pacific include 600 million people who survive on a dollar a day or less, and about the same number who live on just above a dollar – making up a group of about 1.2 billion who are vulnerable. The regions usually spend about half of their budgets on food, but recent increases have pushed that proportion to about 80 percent in some parts of South Asia. The nutrition of the poor is also at risk when they are not shielded from the price rise. Higher food prices lead poor people to limit their food consumption and shift to even less-balanced diets, with harmful effects on health in the short and long run. Donors should expand food-related development aid, including social protection, child nutrition programmes, and food aid. At the same time, developed countries should eliminate domestic bio-fuel subsidies and open their markets to bio-fuel exporters

## Impacts – corn ethanol bad

### Algae solves corn ethanol

#### Algae solves all the sustainability problems of corn

Mark Edwards (Phd and Professor) 2008 Food Marketing, Arizona State University, BIOWAR I: WHY BATTLES OVER FOOD AND FUEL LEAD TO WORLD HUNGER, p. 168

Corn ethanol is not sustainable because it's too resource intensive. Massive growing of corn relies on too many non-renewable resources, especially fossil energy, land, water and subsidies. Algae are sustainable because the plants are truly renewable and production is resource efficient. The added value of C02 sequestration and algae's ability to use available heat from coal-fired power plants and manufacturing facilities provides additional value for algae.

### Monocultures 1nc

#### Status quo biofuels lead to intensive monocultures—poses a serious threat to survival

Oliver Thibault (PHD in Molecular and Biomedical Pharmacology at University of Kentucky) April 18 2007 “Greater Use of Biofuels Threatens Rainforests” http://www.terradaily.com/reports/Greater\_Use\_Of\_Biofuels\_Threatens\_Rain\_Forests\_999.html

Greater use of biofuels as an alternative to fossil fuels will threaten tropical rain forests, biodiversity and food security, environmentalists warned at a two-day summit on biofuels that wrapped up Wednesday in Madrid. It will lead to huge areas of forest to be cleared while food crops will be replaced by the plantation of more profitable "energy crops" like palm and soya, green groups Ecologists in Action and Via Campesina said in a report distributed at the event. "Greater use of biofuels will lead to intensive monocultures in the most vulnerable and most ecological areas of the planet," said the report which called biofuels a "serious threat" to the planet.

#### Monocultures ensure a loss of genetic crop diversity, causes extinction

Cary Fowler andPat Moone**y**, Rural Advancement Fund International, SHATTERING: FOOD, POLITICS, AND THE LOSS OF GENETIC DIVERSITY, 1990, p. ix

While many may ponder the consequences of global warming, perhaps the biggest single environmental catastrophe in human history is unfolding in the garden. While all are rightly concerned about the possibility of nuclear war, an equally devastating time bomb is ticking away in the fields of farmers all over the world. Loss of genetic diversity in agriculture—silent, rapid, inexorable—is leading us to a rendezvous with extinction—to the doorstep of hunger on a scale we refuse to imagine. To simplify the environment as we have done with agriculture is to destroy the complex interrelationships that hold the natural world together. Reducing the diversity of life, we narrow our options for the future and render our own survival more precarious. It is life at the end of the limb. That is the subject of this book. Agronomists in the Philippines warned of what became known as southern corn leaf blight in 1061.' The disease was reported in Mexico not long after. In the summer of 1968, the first faint hint that the blight was in the United States came from seed growers in the Midwest. The danger was ignored. By the spring of 1970 the disease had taken hold in the Florida corn crop. But it was not until corn prices leapt thirty cents a bushel on the Chicago Board of Trade that the world took notice; by then it was August—and too late. By the close of the year, Americans had lost fifteen percent of their most important crop—more than a billion bushels. Some southern states lost half their harvest and many of their farmers. While consumers suffered in the grocery stores, producers were out a billion dollars in lost yield. And the disaster was not solely domestic. U.S. seed exports may have spread the blight to Africa, Latin America and Asia

#### Algae based fuels do not risk monocultures or any fo the biofule drawbacks

ETAP (Environmental Technologies Action Planan) April 2007 Converting Algae into Biofuel”, Initiative from the Environment Directorate-General of the European Commission <http://ec.europa.eu/environment/etap/pdfs/apr07_algae_biofuels.pdf>

Biofuels made from algae do not present the drawbacks usually encountered with biofuels from agricultural sources. Biofuel production may sometimes result in biodiversity loss, as monoculture crops are sometimes developed at the expense of habitats for wildlife. It is also feared that allocation of arable lands to biofuel crops could affect food supplies in developing countries. This has led environmentalists to call for the setting up of EU certification that would distinguish between biofuels according to their environmental performances and would only support the best performing ones. Biofuels made from algae do not present these drawbacks since the algae bioreactor can be built on non-arable land and requires a far smaller surface area. For instance, yield from algae is 1,7 million litres of oil per hectare per year against 181.65 litres for soya bean oil and 2,403 litres for palm oil. Moreover, the algae in the Vertigro system require no pesticides or fertilizers to grow and very little water, which also reduces the pressure on the environment. Algae by-products can also be used in animal feed or as agricultural fertilizer.

### Dead zones 1nc

#### Corn ethanol creates dead zones, collapsing fisheries and the entire ecosystem

Roddy Scheer, “Gulf Dead Zone Grows with Ethanol Demand,” EMAGAZINE, 2008, www.emagazine.com/view/?4036

Scientists believe that an oxygen-depleted “dead zone” in the Gulf of Mexico is growing rapidly as a result of Americans’ increasing appetite for ethanol, a carbon-neutral biofuel derived from corn that can be used as a gasoline additive or as E85, a gasoline alternative in automotive engines. Dead zones form when vast swaths of ocean water are inundated with nitrogen-based fertilizers—such as those used to grow corn in states along the Mississippi River (which empties into the Gulf). Marine life cannot survive in dead zones, and Gulf fishermen are now forced further and further offshore to net marketable catches. Experts estimate that the Gulf dead zone now stretches across some 7,900 square miles. “We might be coming close to a tipping point,” says Matt Rota, director of the water resources program for the nonprofit Gulf Restoration Network. “The ecosystem might change or collapse as opposed to being just impacted.” Just as environmentalists were starting to make some headway convincing farmers in states along the Mississippi River to grow crops less dependent on nitrogen fertilizers, the price of corn doubled due to ethanol demand. Environmentalists are lobbying the federal government to step in and provide subsidies for farmers to use less nitrogen-based fertilizer, but such requests have been ignored by decision makers more concerned with boosting the economy than protecting marine ecosystems. And with the Bush administration making a big push to increase ethanol production over the next decade, a full-blown fisheries crisis might be inevitable.

#### That risks extinction

William Allen, journalist, “Scientists Sketch a Bleak Picture for Oceans,” Journal Of Commerce, 8-5-1999, p. 9.

Picture giant pockets of water that suffocate marine life. Shoreline forests uprooted for resort hotels. And millions of miles of sea floor destroyed by trawling nets. That's just part of a grim scene of the oceans painted by scientists this week at the 16th International Botanical Congress at America's Center meeting in St. Louis. ""The state of the oceans is as grave as the state of the land,'' said Jane Lubchenco, a biologist at Oregon State University. ""The challenges ahead of us are quite overwhelming.'' The report is important because the popular image of the oceans is that they're an infinite and indestructible resource. But Lubchenco reported several new findings about ecological destruction in the oceans. The damage threatens the quality of life for humans as well, she said. ""This continues to indicate the way . . . humans dominate the planet, unlike any other time,'' Lubchenco said. Lubchenco is chair of a National Science Board task force on the environment and former president of two scientific societies: the American Association for the Advancement of Science and the Ecological Society of America. She called for $1 billion in new funding over the next five years to seek the knowledge needed to address these and other environmental problems and to communicate that knowledge effectively to the public. The Botanical Congress, which runs through Saturday, is expected to attract 4,600 scientists from some 100 nations. The central theme: the importance of plants for human survival.

### Peak phosphorus 1nc

#### Ethanol-driven corn demand causes a phosphorus crisis that spurs resources wars between major powers

Leo Lewis (journalist) June 23 2008 “Scientists Warn of Lack of Vital Phosphurs as Biofuels Raise Demand,” The Times <http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article4193017.ece>

Battered by soaring fertiliser prices and rioting rice farmers, the global food industry may also have to deal with a potentially catastrophic future shortage of phosphorus, scientists say. Researchers in Australia, Europe and the United States have given warning that the element, which is essential to all living things, is at the heart of modern farming and has no synthetic alternative, is being mined, used and wasted as never before. Massive inefficiencies in the “farm-to-fork” processing of food and the soaring appetite for meat and dairy produce across Asia is stoking demand for phosphorus faster and further than anyone had predicted. “Peak phosphorus”, say scientists, could hit the world in just 30 years. Crop-based biofuels, whose production methods and usage suck phosphorus out of the agricultural system in unprecedented volumes, have, researchers in Brazil say, made the problem many times worse. Already, India is running low on matches as factories run short of phosphorus; the Brazilian Government has spoken of a need to nationalise privately held mines that supply the fertiliser industry and Swedish scientists are busily redesigning toilets to separate and collect urine in an attempt to conserve the precious element. Dana Cordell, a senior researcher at the Institute for Sustainable Futures at the University of Technology in Sydney, said: “Quite simply, without phosphorus we cannot produce food. At current rates, reserves will be depleted in the next 50 to 100 years. Related Links She added: “Phosphorus is as critical for all modern economies as water. If global water supply were as concentrated as global phosphorus supply, there would be much, much deeper concern. It is amazing that more attention is not being paid to ensuring phosphorus security.” In the past 14 months, the price of the raw material - phosphate rock - has surged by more than 700 per cent to more than $367 (£185) per tonne. As well as putting pressure on food prices, some researchers believe that the risk of a future phosphorus shortage blows a hole in the concept of biofuels as a “renewable” source of energy. Ethanol is not truly renewable if the essential fundamental element is, in reality, growing more scarce, researchers say. Within a few decades, according to forecasts used by scientists at Linköping University, in Sweden, a “peak phosphorus” crunch could represent a serious threat to agriculture as global reserves of high-quality phosphate rock go into terminal decline. Because supplies of phosphates suitable for mining are so limited, a new geopolitical map may be drawn around the remaining reserves - a dynamic that would give a sudden boost to the global importance of Morocco, which holds 32 per cent of the world's proven reserves. Beyond Morocco, the world's chief phosphorus reserves for export are concentrated in Western Sahara, South Africa, Jordan, Syria and Russia. Natural distribution of phosphorus could create a small number of new “resource superpowers” with a pricing control over fertilisers that some suspect could end up rivalling Opec's control over crude oil. The economic battle to secure phosphorus supply may already have begun. China, according to US Geological Survey estimates, has 13 billion tonnes of phosphate rock reserves and has started to guard them more carefully. Beijing has just imposed a 135 per cent tariff on phosphate rock exports to try to secure enough for its own farmers, alarming the fertiliser industry, as well as Western Europe and India, which are both entirely reliant on phosphorus imports. With America's own phosphorus production down 20 per cent over the past three years, it has begun to ship phosphorus in from Morocco. American projections suggest that global phosphorus demand could grow at 2.3 per cent annually just to feed the growing world population, an estimate that was made before the growth of biofuels. Few observers hold out hope of a discovery of phosphorus large enough to meet the continued growth in demand. The ore itself takes millions of years to form, and the prospect of extracting phosphorus from the sea bed presents massive technological and financial challenges. The answer, say crop scienctists, lies in better husbandry of phosphorus reserves: an effort that may require the creation of an international body to monitor the use and recycling of phosphorus.

#### End of the world

Richard Heinberg (Analyst at the Post-Carbon Institute) September 26 2004 “Book Excerpt: Powerdown: Options and Actions for a Post-Carbon World,” Energy Bulletin http://www.energybulletin.net/node/2291

Last One Standing – The path of competition for remaining resources. If the leadership of the US continues with current policies, the next decades will be filled with war, economic crises, and environmental catastrophe. Resource depletion and population pressure are about to catch up with us, and no one is prepared. The political elites, especially in the US, are incapable of dealing with the situation. Their preferred “solution” is simply to commandeer other nations’ resources, using military force. The worst-case scenario would be the general destruction of human civilization and most of the ecological life-support system of the planet. That is, of course, a breathtakingly alarming prospect.   As such, we might prefer not to contemplate it – except for the fact that considerable evidence attests to its likelihood. The notion that resource scarcity often leads to increased competition is certainly well founded. This is general true among non-human animals, among which competition for diminishing resources typically leads to aggressive behaviour. Iraq is actually the nexus of several different kinds of conflict – between consuming nations (e.g., France and the US); between western industrial nations and “terrorist” groups; and – most obviously – between a powerful consuming nation and a weaker, troublesome, producing nation. Politicians may find it easier to persuade their constituents to fight a common enemy than to conserve and share. War is always grim, but as resources become more scarce and valuable, as societies become more centralized and therefore more vulnerable, and as weaponry becomes more sophisticated and widely dispersed, warfare could become even more destructive that the case during the past century. By far the greatest concern for the future of warfare must be the proliferation of nuclear weapons. The US is conducting research into new types of nuclear weapons—bunker busters, small earth-penetrators, etc. Recent US administrations have enunciated a policy of nuclear first-strike. Chemical and biological weapons are of secondary concern, although new genetic engineering techniques may enable the creation of highly infectious and antibiotic-resistant “supergerms”   cable of singling out specific ethnic groups. Additionally, the US has announced its intention to maintain clear military superiority to any potential rival (“full-spectrum dominance”), and is actively developing space-based weapons and supersonic drone aircraft capable of destroying targets anywhere on the planet at a moment’s notice. It is also developing an entirely new class of gamma-ray weapons that blur the critical distinction between conventional and nuclear weapons.

## Impacts – biofuels – food/fuel link – soy

### Algae solves soy

#### Algae will replace the need for ethanol based crops such as corn and sugar- this will lower the demand and price of soy. Also algae will stop the need for more arable land

Alana Herro 2007 World Watch, <http://www.worldwatch.org/node/5391>

One acre of algae can produce enough oil to make 5,000 gallons of biodiesel in a year. Forget corn, sugar cane, and even switchgrass. Some experts believe that algae is set to eclipse all other biofuel feedstocks as the cheapest, easiest, and most environmentally friendly way to produce liquid fuel, reports Kiplinger’s Biofuels Market Alert. “It is easy to get excited about algae,” says Worldwatch Institute biofuels expert Raya Widenoja. “It looks like such a promising fuel source, especially if it’s combined with advances in biodiesel processing.” The inputs for algae are simple: the single-celled organisms only need sunlight, water, and carbon dioxide to grow. They can quadruple in biomass in just one day, and they help remove carbon from the air and nitrogen from wastewater, another environmental benefit. Some types of algae comprise more than 50 percent oil, and an average acre of algae grown today for pharmaceutical industries can produce 5,000 gallons (19,000 liters) of biodiesel each year. By comparison, an average acre of corn produces 420 gallons (1,600 liters) of ethanol per year, and an acre of soybeans yields just 70 gallons (265 liters) of biodiesel per year. “Your bang for your buck is just bigger because you can really do this on a much smaller amount of land and yet yield much, much higher biomass,” said Michael S. Atkins, CEO of San Francisco area-based Ocean Technology & Environmental Consulting (OTEC). Douglas Henston, CEO of Solix Biofuels, a company that grows algae for biofuels, has estimated that replacing all current U.S. diesel fuel use with algae biodiesel would require using only about one half of 1 percent of the farmland in production today. Algae can also grow on marginal lands, such as in desert areas where the groundwater is saline.

### Biofuels = defo

#### Science is on our side, even the next generation of biofuels will cause deforestation. Recent scientific studies have concluded that deforestation is the primary cause of global warming

Global Justice Environment Project January 20 2009 “‘Next Generation’ Biofuels: Bursting the New ‘Green’ Bubble”, http://climateandcapitalism.com/?p=609

Next generation “cellulosic” fuels will not resolve the problems With recognition of the role of agrofuels in driving up food prices, there has been increasing attention to the social and ecological costs of corn and sugar cane derived ethanol. In response, there is now a massive push to develop non-food, so-called cellulosic fuels based on claims that these new feedstocks (grasses, trees, and “waste” products) will not compete with food production and can be grown on “idle and marginal” lands. The incoming Obama Administration is clearly positioning to advocate strongly on this platform. Unfortunately, these claims do not hold up to scrutiny. An enormous additional demand for trees, grasses and other plants, edible or inedible, will not avert the problem of land-use competition. Land that could be used for food crops or biodiversity conservation will be increasingly diverted into energy production. Demand for land for both agriculture and timber is already intense and escalating globally as water, soil and biodiversity dwindle and the climate becomes increasingly unstable. The scale of demand cannot be met sustainably Virtually all of the proposed cellulosic feedstocks (including dedicated energy crops such as perennial grasses and fast growing or genetically engineered trees, agricultural and forestry “wastes and residues”, municipal wastes etc.) present serious ecological concerns on the scale required to maintain biorefinery operations and significantly contribute to U.S. energy demands. Furthermore, renewable fuels targets in the U.S. mandate the use of 15 billion gallons of corn ethanol per year, an amount that requires one third of the nations corn crop, and an additional 21 billion gallons a year of “advanced” agrofuels, the definition of which opens the possibility that demand will be met with foreign sources. The massive new demand for agrofuels is escalating deforestation and resulting in conversion of biodiverse and carbon-rich native forests and grasslands into biologically barren and carbon-poor industrial tree plantations and other crop monocultures. Land use changes resulting from industrial agriculture, including widespread deforestation, are major causes of climate change. Recent research finds that old growth forests sequester far more carbon than was previously estimated, (i.e. Intergovernmental Panel on Climate Change underestimated carbon stocks for temperate old growth forests by two-thirds). This means that deforestation has been a much larger causal factor in global warming than initially thought, and that intact natural forests are critical for sequestering carbon. It is imperative therefore that we protect remaining forests, grasslands and other carbon-rich ecosystems. The widespread application of biotechnology for agrofuel production, including genetically engineered (GE) feedstock crops such as GE grasses and GE trees, and plans to use synthetic biology and other genetic engineering techniques to alter and construct microbes, is an unacceptable and dangerous risk.

### Amazon deforestation 1nc

#### Biofules are the PRIMARY cause of Amazon deforestation- US increase in demand for crops to be used for ethanol production has led to a drop in US soy production—this policy is the number one driver of soy production in Brazil

AFP February 14 2009 “Biofuels may speed up, not slow global warming: study”, http://www.google.com/hostednews/afp/article/ALeqM5gQy7VFLFs365aBNrduM-V\_xSFP8A

The use of crop-based biofuels could speed up rather than slow down global warming by fueling the destruction of rainforests, scientists warned Saturday. Once heralded as the answer to oil, biofuels have become increasingly controversial because of their impact on food prices and the amount of energy it takes to produce them. They could also be responsible for pumping far more carbon dioxide into the atmosphere than they could possibly save as a replacement for fossil fuels, according to a study released Saturday. “If we run our cars on biofuels produced in the tropics, chances will be good that we are effectively burning rainforests in our gas tanks,” warned Holly Gibbs, of Stanford’s Woods Institute for the Environment. Gibbs studied satellite photos of the tropics from 1980 to 2000 and found that half of new cropland came from intact rainforests and another 30 percent from disturbed forests. “When trees are cut down to make room for new farmland, they are usually burned, sending their stored carbon to the atmosphere as carbon dioxide,” Gibbs said. For high-yield crops like sugar cane it would take 40 to 120 years to pay back this carbon debt. For lower yield crops like corn or soybeans it would take 300 to 1,500 years, she told reporters at a meeting of the American Association for the Advancement of Science. “Biofuels have caused alarm because of how quickly production has been growing: Global ethanol production increased by four times and biodiesel by 10 times between 2000 and 2007,” Gibbs said. “Moreover, agricultural subsidies in Indonesia and in the United States are providing added incentives to increase production of these crops.” Gibbs estimates that anywhere from a third to two thirds of recent deforestation could be as a result of the increased demand for biofuels, but said an increased demand for food and feed also play a major role. What is certain is that much of the expansion of cropland in response to growing demand and rising prices is occurring in the tropics where there is an abundance of arable land and climates ideal for growing biofuel crops like sugar cane, soy and oil palm. Simply growing the biofuel crops in the United States or other non-tropical countries will not solve the problem, said Michael Coe of the Woods Hole Research Center. Recent legislation mandating increased use of ethanol has already prompted US farmers to switch from soy to corn production. But since soy demand remains high, farmers in Brazil have responded by cutting down forests to expand soy production.

#### There is a direct market correlation between high soy pices and Amaon destruction

Dr. Rachel Smolker (Agrofuels Specialist, Global Justice Ecology Project) 1-15-2009, M2 PressWIRE, Global Justice Ecology Project: "Next Generation Biofuels": Bursting The New "Green" Bubble Letter challenges unrealistic promises from an unsustainable industry

Deforestation in the Amazon is directly correlated with the market price of soy, a biofuel feedstock. When farmers in the U.S. switched from soy to corn production to meet the demands for corn ethanol, the price of soy rose, and deforestation increased. The push for more land to grow energy crops has resulted in the elimination of set-aside lands in the EU and a reduction of CRP lands in the U.S. The loss of these critical habitats is reducing pollinator and bird populations dramatically.

#### This causes nuclear war and disease spread

David Takacs (Teaches Environmental Humanities at the Institute for Earth Systems Science and Policy at California State) 1996 The Idea of Biodiversity: Philosophies of Paradise, Pg. 200-201

So biodiversity keeps the world running. It has value and of itself, as well as for us. Raven, Erwin, and Wilson oblige us to think about the value of biodiversity for our own lives. The Ehrlichs' rivet-popper trope makes this same point; by eliminating rivets, we play Russian roulette with global ecology and human futures: "It is likely that destruction of the rich complex of species in the Amazon basin could trigger rapid changes in global climate patterns. Agriculture remains heavily dependent on stable climate, and human beings remain heavily dependent on food. By the end of the century the extinction of perhaps a million species in the Amazon basin could have entrained famines in which a billion human beings perished. And if our species is very unlucky, the famines could lead to a thermonuclear war, which could extinguish civilization."Elsewhere Ehrlich uses different particulars with no less drama: What then will happen if the current decimation of organic diversity continues? Crop yields will be more difficult to maintain in the face of climatic change, soil erosion, loss of dependable water supplies, decline of pollinators, and ever more serious assaults by pests. Conversion of productive land to wasteland will accelerate; deserts will continue their seemingly inexorable expansion. Air pollution will increase, and local climates will become harsher. Humanity will have to forgo many of the direct economic benefits it might have withdrawn from Earth's well-stocked genetic library. It might, for example, miss out on a cure for cancer; but that will make little difference. As ecosystem services falter, mortality from respiratory and epidemic disease, natural disasters, and especially famine will lower life expectancies to the point where cancer (largely a disease of the elderly) will be unimportant. Humanity will bring upon itself consequences depressingly similar to those expected from a nuclear winter. Barring a nuclear conflict, it appears that civilization will disappear some time before the end of the next century - not with a bang but a whimper.

#### Amazon destruction risks life on earth – we’re nearing the tipping point

Timothy V. Gatto 4-25-2008 LiberalPro, The "Tipping Point" and "Critical Mass" in America and the World

Just how many issues are facing critical mass while lingering at the tipping point? The way I see it, the volume of critically important decisions that must be made, and made soon, dwarfs any other period I have seen in my lifetime. The facts are that issues, problems and crisis are merging together to make a perfect storm that will affect the entire human race, sparing no one. While this may appear to be frightening to many, because of the threats that these issues pose to humanity, they cannot be ignored, and not dealing with these problems is no longer an option. These issues threaten our very existence as a species. Just what are these issues that are such a threat to mankinds continued existence? While many people and governments attempt to remain blithely ignorant of the situation, global climate change threatens to destroy upwards to half of all species of life on this planet. The irresponsible behavior of mankind towards the Earth is criminal in nature. The Amazon rain forest, which supplies twenty percent of the planets oxygen as well as removing nearly the same amount of carbon dioxide, is being destroyed at a rate which translates to an area the size of Belgium, being destroyed yearly. The Amazon rainforest which can be likened to the lungs of our planet can never be replaced. The discharge of fresh water from the mouth of this largest of rivers, makes up twenty percent of the fresh water discharged into the oceans. In fact, one minute of fresh water discharge from the Amazon into the Atlantic could provide New York City with its entire water needs for sixty years. The habitat of plants that havent yet been discovered, plants that could contain medicinal properties and cure disease, are being destroyed before scientists can evaluate their properties and possible uses. Once a species is gone from the Earth, it is gone forever. In this regard, there is no second chance.

#### Qualified sources agree – oxygen levels are already collapsing

Curing Oxygen 2007 What's Happening to our Oxygen?, http://curingoxygen.com/oxygen\_problem.htm

LOW BODY OXYGEN LEVELS MAY JUST BE THE CAUSE OF ALL SICKNESS & DISEASE! "All chronic pain, suffering and diseases are caused from a lack of oxygen at the cell level." Dr. Arthur C. Guyton, M.D.: The Textbook on Medical Physiology Atmospheric Oxygen Levels Are Declining! After decades of controversy in the scientific community, research has confirmed that oxygen levels have been declining, and continue to decline. Pollution is a major factor that has affected the quality, and quantity, of oxygen available for respiration and metabolism. Scientists have analyzed oxygen specimen trapped in amber and have determined that oxygen levels at one time were in excess of 35% to as much as 50%! Prior to the advent of the gasoline combustion engine at the turn of the last century, oxygen levels in the air were at about 23%. By the mid 1900s, levels had dropped in major cities to about 19%. By the end of the 20th century, major cities across the globe have reported levels at 15%, and several cities have reported alarmingly low levels, combined with industrial pollution at 10%. This level, if maintained for a prolonged period of time will choke out life. Major Sources of Oxygen Production Are Affected: One of the major sources of oxygen on our plant is the waste product of plant respiration (photosynthesis). Plants require carbon dioxide (CO2) to synthesize the energy they need to grow and reproduce. A waste product of their metabolic cycle is Oxygen (O2). Thus, plants and mankind have a wonderful symbiotic relationship. Tropical rainforests produce 40% of Earth's oxygen. The Amazon Rainforest has been described as the "Lungs of our Planet" because it continuously recycles carbon dioxide into oxygen.

#### Collapse of oxygen levels will cause extinction – oceans can’t sustain it alone

The Guardian 8-15-2008, Global Oxygen Level Falling, Warn Scientists

The world has realized the danger of rising carbon dioxide (CO2) emissions. It has, in its own way, been fighting global warming. But what about the long-term fall in oxygen levels and its knock-on effects? Compared to prehistoric times, the level of oxygen in the earth's atmosphere has fallen by over a third and in polluted cities the decline could be more than 50 percent. This change in the makeup of the air we breathe has potentially serious implications for our health. Indeed, it could ultimately threaten the survival of human life on earth, says Roddy Newman, who is drafting a new book, The Oxygen Crisis. So, what's the evidence? About 10,000 years ago, the planet's forest cover was at least twice what it is today, which means forests are now emitting only half the amount of oxygen. And desertification and deforestation are rapidly accelerating this long-term loss of oxygen sources. The story at sea is much the same. NASA reports that in the north Pacific Ocean oxygen-producing phytoplankton concentrations are 30 percent lower today, compared to even the 1980s. This is a huge drop in just three decades.

### Indonesia stability 1nc

#### High soy prices independently create instability in Indonesia

Belinda Lopez 2-15-2008, Agence France Presse – English, Indonesia's poor suffering as high soy prices hit home

With high soybean prices signalling a possible end to cheap staple foods in Indonesia, the suicide of a food vendor has become a symbol of widespread hardship. Slamet, 49, was found hanging in his house on the morning of January 16, a day after he had made just 8,000 rupiah (85 cents) at the local market in this town in the western Javanese province of Banten, his wife, Nuriah, told AFP. Spiralling prices for tofu and tempeh, a fermented soy cake, have prompted protests from sellers and panic among households in Indonesia, where there are fears a key source of protein is moving out of reach for millions of poor. Days before his death, Slamet appeared on television along with other local food sellers protesting the high soybean prices. "He felt his objections focused on the government, that the government needed to pay attention to poor people like himself," a tearful Nuriah says. "Slamet said he was tired of a difficult life. He said he tried so hard in life, but there was never any change." The crisis has highlighted Indonesia's reliance on imported soybeans, prices of which are surging along with other global commodities. Soybean prices have risen drastically in the last year, in line with the trend of soaring commodities prices worldwide. In Indonesia today, a tonne of soybean costs 610 dollars, when only a year ago it was 332 dollars. Indonesia imported 1.3 million tonnes of soybeans last year, 65 percent of its total domestic consumption, according to the American Soybean Association. But as prices have climbed, ordinary Indonesians have felt the pain.

#### This leads to disintegration

Asia Pulse 3-2-2004 KKN CAN BECOME CAUSE OF NATIONAL DISINTEGRATION, OBSERVER SAYS

If the intention of the rotten politicians most of whom are from KKN ring could really materialize, structural poverty will truly happen in the country and the international world will brand Indonesia as a 'sick man'. Amid the worsening conditions of life, as usual the stability of security will also be affected. At the time when the government is unable to face the waives of protests as moral force movement from many people, it is feared that the chaostic situation may give birth to the intention to separate from the unitary state of Indonesia.

#### Collapses the global economy and crushes relations with China

Rajan Menon (Professor of International Relations at Lehigh University,) The National Interest, Fall 2001, p. 101

Indonesia's size and location are the reasons why. The three major straits that slice through it are pivotal passages for the global economy. Malacca is by far the most important, particularly for energy shipments. Some 450 vessels and about 10 million barrels of oil pass through daily, and East Asian demand, driven by China, is expected to rise from 12 million barrels a day in 2000 to over 20 million barrels in twenty years. Japan, China, Taiwan and South Korea would suffer severely and soon if fallout from turmoil in Aceh (at its northern end) or Riau (at its southern end) blocked this passage. Its narrowness, 1.5 miles in the Phillips Channel in the Singapore Strait, and ten miles between Singapore and the Riau archipelago, adds to the danger. The Lombok Strait, which ships use to sail to northeast Asia through the Strait of Makasar between Borneo and Sulawesi, is next in importance, although it handles a far smaller volume of traffic than Malacca and is of negligible importance for energy shipments. The L ombok-Makasar route is, however, a critical corridor for Australia's coal and iron ore exports to northeast Asia and for manufactured exports moving south from there. It is also the most likely detour were Malacca rendered impassable or hazardous. By comparison, Sunda is a minor shipping channel; the consequences of its closure would be minimal for transcontinental trade. Rerouting Malacca traffic through Lombok would strain the capacity of the world's merchant fleet, increase transportation costs, and create severe bottlenecks. The problems would be even worse if all three straits were unusable and ships had to transit northeast Asia by skirting Australia's northern coast. Market signals would eventually add other carrying capacity but the question is how quickly and smoothly the adjustment occurs, and what the economic and political consequences would be in the meantime. The ramifications of blocked or delayed maritime traffic, or even just panic over the possibility, would spread speedily throughout globalization's many circuits. Insurance rates would rise; coverage may even be denied if underwriters deem the risks excessive. The effects of obstructed energy, machinery and manufactured goods would register in capital markets, short-term investors would be scared off, and the flow of much-needed foreign direct investment into a region still convalescing from the blows of 1997 would slow. Piracy in the seas around Indonesia would also worsen if the Jakarta government either ceased functioning or were so busy holding the country together that it could not police its waters. The hijacking of ships has increased since Indonesia's upheavals began. There were 113 incidents in its waters in 1999 compared to 60 the year before, and between January and March of 2001 alone, pirates attacked ships in Indonesian waters 29 times and on nine occasions in the Malacca Strait. The vessels victimized near Malaysia, Singapore and Indonesia included several oil tankers and ships carrying aluminum and palm oil. The three countries began to coordinate operations against the menace in 1992, and in 2000 Japan proposed that its coast guard join the effort along with China and South Korea. Yet how serious piracy becomes, and how effective any joint solution is, depends primarily on the extent of Indonesia's stability. Refugee flows will also accelerate if Indonesia starts to break apart. The refugee population of one million already within its borders will soar, dragging the economy down further and aggravating communal violence. Refugees could also be driven beyond Indonesia into neighboring countries that are neither prepared to receive them nor able to bear the burden of caring for them. Malaysia, which lies across the water from Aceh, has already seen rising illegal immigration from Indonesia, and its officials worry about the social tensions that could result. The refugee problem also figures prominently in Australian and Singaporean discussions of Indonesia. Indonesia's neighbors have other worries, as well, as they watch this wobbly behemoth. For Malaysia, one is that the Malaysian Islamic Party, already powerful in northern Malaysia, could receive a fillip were militant Islam to become more significant in Indonesia's politics as a result of the turmoil-or were it to dominate its successor states. Thailand and the Philippines, which have breakaway Islamist groups in their southern regions, fear that Indonesia's collapse could produce an undesirable demonstration effect. Papua New Guinea, which borders West Papua, could be swamped by refugees and also face an older problem: incursions from the Indonesian military in hot pursuit of Papuan guerrillas. Singapore and Malaysia have invested in pipelines carrying energy from Riau and from Indonesia's Natuna gas fields (located in the South China Sea between peninsular Malaysia and Sarawak) and are watching nervously. ASEAN, whose economic and political clout has fallen short of members' hopes, will be reduced to a sal on if Indonesia, its keystone, crumbles. Neither is it clear how Japan, China and Australia would react to various scenarios in Indonesia. Few convergent interests unite them, and history has done much to divide them. This augurs ill for cooperation on economic assistance, refugee relief, piracy, or peacekeeping to stem Indonesia's unraveling or to deal with the consequences if that proves impossible. Indeed, anarchy in Indonesia could start a scramble among these states that is driven more by fear, uncertainty and worst-case thinking than by the opportunistic pursuit of advantage. A process leading to sponsorship of competitive proxy proto-statelets that rise from Indonesia's wreckage is an extreme scenario, but cannot be ruled out. Beyond the general tendency of states divided by suspicion to jockey for position when uncertainty or opportunity prevails, there are other specific motives for intervention. China could be drawn into the fray if Indonesia's seven-million-strong Chinese population, which has often been a scapegoat in times of trouble, were to be victimized. Beijing's increasing concern for secure energy supplies since becoming a net importer in 1993 has already made it more assertive in the South China Sea, and could provide another motive. Given Indonesia's uncertain future, Chinese maps depicting Beijing's jurisdiction over Indonesia's Natuna gas fields are a worrisome portent, particularly for Malaysia and Singapore, who envision energy pipelines from this site. Japan would move cautiously if Indonesia begins to resemble a lost cause, but it depends on Indonesia's straits and owns most of the ships that ply them. Tokyo cannot remain utterly passive if Indonesia's crisis disrupts the Japanese economy, or if others states assert their interests in ways that could do so. Indonesia's importance for Australia goes beyond the significance of the Lombok-Makasar passage. In a region being shaped by China's growing power, Indonesia, by virtue of its location and size, is central to Australian national security. Its collapse would lay waste to much of Australia's strategic planning. The consequences of Indonesia's breakup would affect American interests, as well. American energy and raw materials companies (Exxon-Mobil, Texaco, Chevron, Newmont Mining, Conoco and Freeport-McMoRan, among others) operate in Indonesia, particularly in Aceh, Riau, and West Papua, and many of the ships that traverse the Strait of Malacca are American-owned. The United States is also a major trader and investor in East Asia and is to some degree hostage to its fate, especially now that the American economy is slowing. Moreover, if Indonesia fractures, worst-case thinking and preemptive action among its neighbors could upset regional equilibrium and undermine the American strategic canopy in East Asia. The United States has a network of bases and alliances and 100,000 military personnel in the region, and is considered the guarantor of stability by most states-a status it will forfeit if it stands aside as Indonesia falls apart. America's competitors will scrutinize its actions to gauge its resolve and acumen. So will its friends and allies-Australia, Japan, Singapore, Thailand and South Korea-each of whom would be hurt by Indonesia's collapse.

#### Loss of relations risk extinction

William Ratliff, Senior Research Fellow at the Hoover Institution, 7-31-95, Washington Times

Much of the growth and prosperity of the Pacific Rim countries in general – ranging from Japan and China through Southeast Asia to the United States and the Pacific Coast of South America –depends on peace and stability in East Asia. The United States and China must lead other nations in fostering this peace and stability. Today, this means cooperating onsuch varied issuesas the potential nuclear threat of North Korea, the resolution of the China-Taiwan controversy and the exploration of – and safety of sea lanes through – the South China Sea, the superhighway of the Southeast Asian economic miracle. These matters will recur, and other problems unforeseen today will turn up, in the years ahead. So the world spins. To be sure, cooperation often will not be easy, for fear as to Chinese intentions pervades Washington and suspicions of U.S. motives remain widespread here in China.Americans, for example, are particularly concerned at the size of the Chinese military budget and what Beijing intends to do with its modernized and expanded military capacity. Thus as Mr. Perry noted, increasing contacts between the militaries of the two countries, and each nation's clearer understanding of the defense policies and strategic intentions of the other, are essential. This was the particular importance of Mr. Perry's visit to the PLA gathering, a type of exchange both sides must foster in the future for everyone's good. Short-term issues are not necessarily unimportant because they are short-term, but they must be worked out by each side having consistent policies the other can understand that look beyond short-term problems to longer-term interests. The high probability is that the United States and China will be the two superpowers of the early 21st century and our living together in peace will be essential to the prosperity if not the survival of the world.

## Impacts – airline industry

### Airline industry 1nc

#### Algae jet fuel is the only sustainable solution to the airline industry’s dependence on fossil fuels

Chris Kjelgaard (Senior Editor) 6/26/2008 “Biofuels Become Aviation’s Big Focus”, http://www.aviation.com/technology/080626-biofuel-is-aviation-focus.html

For aviation, it increasingly appears that biofuels — jet fuels made from plants or algae using any one of a variety of processes — represent by far the best medium-to-long-term hope for the economic and environmental survival of the industry. One of the main advantages of biofuels is that the plants used to make the fuels need lots of CO2 to grow, potentially making it possible for the aviation industry to achieve true carbon-neutrality. "Boeing Commercial Airplanes and its partners are actively accelerating development of second-generation biofuels because they present an economically viable opportunity to sustainably power the world's commercial aircraft fleet," said Boeing in a recent briefing document entitled 'What is the future of jet fuel?' Aviation's 'proven track record' Aviation's "proven track record" in reducing its "carbon footprint" on a per-passenger basis already is excellent, with a 70 percent improvement in fuel-efficiency and CO2 emissions per passenger mile in the last 50 years, said Rolls-Royce senior environmental analyst Nuno Taborda. "Aviation spends relatively more than any other industry on CO2 reduction," he said. Others noted that during the last 30 years, the U.S. automobile industry did not improve the fuel-efficiency and CO2 emissions of its products at all. But civil aviation is only just starting. "The IATA (International Air Transport Association) goal is for a 25 percent emissions reduction per passenger by 2020," from an average of 4 kilograms of CO2 per 100 passenger kilometers to 3 kilograms, said Billy Glover, Boeing Commercial Airplanes' managing director of environmental strategy. In the U.S., "the Air Transport Association goal is for 30 percent by 2025." These goals do not include any positive effects from using sustainable biofuels which might be available by then, Glover added. Various partnerships have been established to foster the development of alternative fuels and other ways to improve aviation's environmental efficiency. It is one area on which Airbus and Boeing cooperate willingly. One leading forum is the Commercial Aviation Alternative Fuels Initiative (CAAFI), which includes partners from the aviation industry, fuel suppliers, universities, and various U.S. government agencies. CAAFI has established a fuel-certification roadmap that envisages achieving certification of jet fuels made entirely from biomass-derived pure hydrogenated oils in 2013. CAAFI also has set several intermediate targets, beginning this year with the planned certification of a fuel made from a 50 percent blend of biomass-derived syngas and conventional jet fuel. (Syngas is a mixture of carbon monoxide and hydrogen and is created from feedstock by the Fischer-Tropsch process, which was discovered in 1923. Syngas can be processed into jet fuels.) Finding the right biofuel feedstock Key to the entire aviation biofuel issue is just what type of biomass is most suitable for fuel production. Several vital issues must be taken into account. First is the density and energy content of the fuel: It must take up a sufficiently small space that it can be carried in an aircraft and, similarly, a given volume of the fuel must produce enough energy so that an aircraft can carry enough in its tanks to complete its flight. Second is the "carbon lifecycle" of the biofuel: that is, the net amount of CO2 produced during production and burning of the fuel, less the amount the biomass feedstock for the fuel absorbs while growing. Third is the amount of sulfur and other particulates produced. Fourth is the hugely sensitive political issue of making sure the land and biomass used to make biofuel does not reduce the amount of food available to humanity and the Earth's fauna. These considerations immediately rule out "first-generation biofuels" such as ethanol produced from corn and soybeans. Not only does ethanol not contain enough energy per unit volume to be suitable as an aviation fuel, but growing enough corn or soybeans to power all the world's airliners would require an area just about the size of the United States, according to Boeing. Nor does ethanol have suitable boiling and freezing points for aviation use. Second-generation biofuels Experts believe "second-generation biofuels" derived from the wood and nuts of plants such as Jatropha curcas (Barbados Nut) and babassu, which grow strongly in arid areas unsuitable as arable land and which (in jatropha's case) are poisonous anyway, represent a good interim solution. These Latin American plants, as well as other flora such as switchgrass and salt-water-tolerant plants known as halocytes (among them marsh grasses found in parts of the Middle East), could be grown for fuel production in non-arable areas suited to their particular growth requirements. Different parts of the world would grow different biofuel-producing plants, depending on their local climatic and soil conditions. However, there is a problem: Although their oils offer much higher energy content and much better boiling/freezing-temperature characteristics than ethanol, these plants wouldn't yield enough oil per hectare to be able to serve the aviation industry's fuel requirements unless, again, very large areas were given over to their cultivation. Algae a likely long-term answer There is broad consensus throughout the industry that, longer-term, algae represent the optimum solution to aviation's fuel needs. A number of basic problems need to be solved, such as ensuring enough light gets to every part of an algae tank to enable all the cells to grow properly; and drying algae cells sufficiently to enable the oil they contain to be extracted and cracked into jet fuel. But Boeing and Airbus are confident these problems can be solved — and the benefits that algae offers as a "third-generation biofuel" are immense. Algae can produce an oil yield 15 times that of second-generation biofuel plants: The world's entire airliner fleet could be powered from a cultivated area just the size of West Virginia, or Belgium, says Boeing. Additionally, because algae can be grown in tanks anywhere, biofuel-producing algae farms could be sited next to facilities producing jet fuel from coal or natural gas using the Fischer-Tropsch process. These "coal-to-liquid" or "gas-to-liquid" processes generate large amounts of CO2 from fossil fuels, making them unsuitable as sustainable fuel sources. However, if the CO2 they generate is piped off and used to grow algae in nearby farms, the two forms of fuel production together could create an efficient, carbon-neutral symbiosis for jet fuel production.

#### Reliance on fossil fuels will collapse the airline industry now, taking the global economy with it

Reed Business Information 8/1/2008. “Airline Woes Could Cut Deep,” HOTELS

http://www.hotelsmag.com/article/CA6583066.html

The cost of jet fuel is skyrocketing, causing serious economic woes for airlines—especially in the United States—and higher ticket prices, along with onerous fuel surcharges. The International Air Transport Association (IATA) predicts airline losses in 2008 could reach US$6.1 billion. “The situation is desperate and potentially more destructive for the industry than our recent crises—SARS, terrorism and war—combined,” says Giovanni Bisignani, director general and CEO of IATA. “Large parts of the industry are being re-shaped. In the last six months 24 airlines went bust. To keep this vital part of the global economy functioning, governments, industry business partners and labor all have a critical role to play.”

#### Economic collapse causes extinction.

T.E. Bearden (LTC U.S. Army (ret) Director of Association of Distinguished American Scientists and Fellow Emeritus, Alpha Foundation’s Institute for Advanced Study) 2000 “The Unnecessary Energy Crisis: How to Solve It Quickly”, 6-24-2k, http://www.seaspower.com/EnergyCrisis-Bearden.htm

History bears out that desperate nations take desperate actions. Prior to the final economic collapse, the stress on nations will have increased the intensity and number of their conflicts, to the point where the arsenals of weapons of mass destruction (WMD) now possessed by some 25 nations, are almost certain to be released. As an example, suppose a starving North Korea launches nuclear weapons upon Japan and South Korea, including U.S. forces there, in a spasmodic suicidal response. Or suppose a desperate China, whose long-range nuclear missiles (some) can reach the United States, attacks Taiwan. In addition to immediate responses, the mutual treaties involved in such scenarios will quickly draw other nations into the conflict, escalating it significantly. Strategic nuclear studies have shown for decades that, under such extreme stress conditions, once a few nukes are launched, adversaries and potential adversaries are then compelled to launch on perception of preparations by one's adversary. The real legacy of the MAD concept is this side of the MAD coin that is almost never discussed. Without effective defense, the only chance a nation has to survive at all is to launch immediate full-bore pre-emptive strikes and try to take out its perceived foes as rapidly and massively as possible. As the studies showed, rapid escalation to full WMD exchange occurs. Today, a great percent of the WMD arsenals that will be unleashed, are already on site within the United States itself . The resulting great Armageddon will destroy civilization as we know it, and perhaps most of the biosphere, at least for many decades

## Politics NB

### Bipartisan support

#### The counter plan solves the case and is bipartisan.

Energy Washington Week, ‘8

[“Senate Energy Committee Eyes RFS revision to ease rising food prices” June 18, 2008, l/n]

Key members of the Senate Energy & Natural Resources Committee are suggesting changes are needed to the recently enacted renewable fuels standard to allow greater use of non-agriculture-based feedstocks in fuel production in response to rising food prices. The senators say the RFS definition should be expanded to include algae-derived fuels, referred to as "green crude" and other emerging technologies, as well as forestry wastes. The senators' comments are significant because they might indicate a political compromise in the emerging food versus fuel debate, which has prompted some Senate Republican leaders to call for a freeze on the current RFS. But committee senators, both Democrats and Republicans, are suggesting a broadening of the RFS definition could address the issue. At a June 12 committee hearing, a senior DOE official also indicated support for such revisions to the RFS. The current RFS, enacted as part of the 2007 energy law, requires the use of 36 billion gallons of renewable fuels by 2022. At the hearing, Sens. Ron Wyden (D-OR) and Bob Corker (R-TN) both expressed strong support for changes to the RFS. Wyden said a provision that prohibits woody biomass culled from national forest land needs to be re-examined, while Corker said the RFS definition needs to be expanded to include algae-based fuels. Rising global food prices have led some lawmakers to call for the RFS to be dramatically reduced, either permanently or for one year. But committee Chairman Jeff Bingaman (D-NM) appeared reluctant to change the mandate so drastically, saying it would chill investment in a second generation biofuels. Rather than these changes, he suggested that diversifying the feedstocks away from food crops would be a better path. A committee staffer describes the hearing as a "fact-finding" effort which could inform legislative changes to the RFS. An industry source said legislation would likely be introduced next year. "I am concerned that altering that path now would not only be unfair to the industry that is responding to the government policies that have already been put in place, but also would have negative implications for second-generation fuels," Bingaman said at the hearing. "As we diversify away from biofuel feedstocks that compete with our grain supply, we also diversify the geographic production areas beyond the current base in the Midwest." The controversy is prompted in part by last-minute changes made in conference negotiations to last year's energy bill to adopt a House-approved definition for the RFS, which focused on corn-based ethanol and other agriculture-based fuels. Senators now are looking to revise the RFS to reflect the more expansive definition included in the original Senate-passed energy bill. At the Senate energy committee hearing, Jason Pyle, CEO of Sapphire Energy, which produces an algae derived fuel that can be integrated into the current petroleum-based infrastructure, said the fuel his company is producing is not admissible under the current RFS, which should be revised to ensure technological neutrality. "Congress should ensure that the next round of incentives can be applied to advanced technologies such as Sapphire's," he testified. "American innovation is the heart of our people and our economy; I urge you to support this with additional legislation that promotes a technology neutral RFS." Sen. Corker backed that assertion. "I could not agree more and I hope we can work with you and the committee to see that that happens." He said revising the RFS would reduce pressure on agricultural lands to produce fuel. DOE Assistant Secretary for Energy Efficiency and Renewable Energy Alexander Karsner also argued for a more "neutral" approach to the RFS, and said a "consolidated, single point of stimulus that is technology neutral, predictable, long term, and...carbon weighted" is needed. In an apparent effort to add detail to his recommendation, Karsner pointed to the definition of renewable fuels in the Energy Policy Act of 1992 as a model for revising last year's energy law. Sen. Wyden focused his comments on a provision in the current law that excludes biomass culled from federal lands from being used to meet the RFS. "When our country is so concerned about these skyrocketing food prices, we ought to be using as much cellulosic material that we possibly can," he said. "But you can't do that because anything grown on federal land is out for the purpose of defining biomass and the RFS." Karsner agreed, and cited a Georgia facility being built under a DOE cost-share program that has to dramatically increase the distance of its feedstock shipments, and avoid receiving wastes from a nearby federal forest, to ensure its fuel meets the current the RFS. "There is not a good rational reason why we should exclude biomass from federal lands," he said. Joseph Glauber, chief economist at the Department of Agriculture, also argued that the current RFS is flawed. At a February hearing, Bingaman indicated he would support the changes to the RFS, noting the current law appears to "micromanage" the market and may exclude "biocrude from algae." He also said the "definition of 'renewable biomass' from which the required biofuel can be derived is too narrow. Examples of excluded feedstock include woody biomass from hazardous fuels reduction on federal lands, and urban and commercial wood waste." -- Will Harrington

### Lobbies

#### Airline, Farm, and biotech lobbies support the CP

Casey 5/26

(Tina Casey is a writer for CleanTechnica the #1 most-visited clean energy or cleantech news site in the US the most indispensable site on the planet for cleantech news and commentary, 5-26-12, “Airlines, Farm Groups Petition Senate for Military Biofuels”, http://cleantechnica.com/2012/05/26/airlines-farm-groups-petition-senate-military-biofuels/)

[**Airlines for America**](http://www.airlines.org/Pages/Home.aspx)**, the** [**American Farm Bureau Federation**](http://www.fb.org/index.php?action=newsroom.home) **and other groups banded together last week to ask the Senate Armed Services Committee to quit blocking biofuels and** [**alternative fuels for the Department of Defense**](http://www.businesswire.com/news/home/20120524006463/en)**.The unusual alliance teams traditional industry and agriculture associations with alternative energy leaders including the** [**Advanced Biofuels Association**](http://www.advancedbiofuelsassociation.com) **and the** [**Algal Biomass Organization**](http://cleantechnica.com/2012/05/26/airlines-farm-groups-petition-senate-military-biofuels/www.algalbiomass.org)**. U.S. military and alternative fuels** As covered numerous times in CleanTechnica ([here](http://cleantechnica.com/2011/09/14/u-s-air-force-energy-sustainable-but-is-going-green-anyways/), [here](http://cleantechnica.com/2011/12/22/u-s-army-goes-all-jay-leno-on-cyclone-biofuel-steam-engines/) and [here](http://cleantechnica.com/2012/02/11/u-s-navy-joins-biofuels-with-battleship-the-green-movie/)), the Department of Defense is a key research partner and eager customer for the alternative energy sector, including [solar](http://cleantechnica.com/2012/03/15/u-s-army-trains-for-combat-with-solar-power/), wind and geothermal as well as liquid fuels. The military’s interest in fuel diversity and clean energy is straightforward. As a fact-based organization (facts being literally a life-and-death matter), DoD recognizes that fuel diversity will play a critical role in its future effectiveness, both in military and humanitarian operations. DoD also recognizes the importance of managing greenhouse gas emissions, as a means of tempering emerging threats and conflicts related to global warming. Penny wise and fuel foolish In blocking the DoD’s purchase of alternative fuels, both the House and Senate committees did not provide a long term strategic rationale for the decision. The new policy is simply based on current prices. If it stands, the new policy prevents DoD from purchasing any alternative fuels that cost more than fossil fuels. In addition, the Senate also tacked on a provision blocking DoD from building biofuel refineries without specific authorization from Congress. Oil, biofuels and budgets **In its letter last week to the Senate committee, the group (including the Biotechnology Industry Organization, Growth Energy, and the Pew Charitable Trusts along with the aforementioned ones) aimed squarely at the lack of foresight behind the new policy: “Continued reliance on foreign oil puts U.S. national security at risk. Oil market volatility has already wreaked havoc on military budgets, which came at the cost of new equipment and training for our troops and reduced military readiness.”** In just the past couple of years, according to the letter, DoD had a $5.6 billion shortfall in military operations and maintenance due to unanticipated higher fuel costs. Building an alternative fuel market Thanks in part to purchasing and research support from DoD and other federal agencies, the cost of military grade biofuels in test quantities has plunged over the past two years, and the letter notes that commercial-scale production will lead to further declines. In that context, the [maneuvering in Congress](http://grist.org/energy-policy/senate-republicans-join-house-in-second-guessing-military-leaders-on-biofuels/) seems more and more like a desperate, last ditch attempt to monkey wrench the inevitable transition to alternative fuels, rather than a responsible exercise of legislative authority.

### Link Non-UQ

#### Obama JUST invested funding to algae

Lane 2/27

(Jim Lane is a writer for Biofuels Digest a news source focusing on biofuels development, 2-27-12, “[Obama touts algal biofuels; $14M in new R&D funding; $2.28 per gallon algal biofuels in sight?](http://www.biofuelsdigest.com/bdigest/2012/02/27/obama-touts-algal-biofuels-14m-in-new-r-2-28-per-gallon-algal-biofuels-in-sight/)”, <http://www.biofuelsdigest.com/bdigest/2012/02/27/obama-touts-algal-biofuels-14m-in-new-r-2-28-per-gallon-algal-biofuels-in-sight/>)

As President **Obama highlights the role of algal biofuels in the long-term energy strategy**, critics and supporters duke it out over the nearer-term prospects, as R&D spending increases. In Washington, the **Obama** Administration **outlined a new $14 million round of R&D grants for algal biofuels, as the US President** [**highlighted algal biofuels in a speech**](http://www.whitehouse.gov/the-press-office/2012/02/23/remarks-president-energy) **at the University of Miami which focused on energy policy.** In Miami, the President said: “**We’re making new investments in the development of gasoline and diesel and jet fuel that’s actually made from a plant-like substance — algae. You’ve got a bunch of algae out here, right? If we can figure out how to make energy out of that, we’ll be doing all right. Believe it or not, we could replace up to 17 percent of the oil we import for transportation with this fuel that we can grow right here in the United States. And that means greater energy security. That means lower costs. It means more jobs. It means a stronger economy.” $14 million for algal biofuels R&D: DOE** Through ARPA-E, **the Energy Department will make $14 million available to support research and development into biofuels from algae,** which it said has the potential to replace up to 17 percent of the United States’ imported oil for transportation. In addition, algae feedstocks offer additional benefits, such as an ability to be grown in ponds near industrial facilities where algae can feed off the carbon emissions from power plants or digest nitrogen and phosphorous from municipal waste water. The Department is currently supporting more than 30 algae-based biofuels projects, representing $85 million in total investments.

## A2 args

### A2 Algae not viable

#### Will be commercially viable by next year

Timoty Gardner June 11 2008 “Algenol Trains Algae to Turn Carbon into Ethanol,” Reuters www.reuters.com/articlePrint?articleId=USN1032368520080611

NEW YORK (Reuters) - Private U.S. company Algenol plans to make ethanol from a primordial green soup that won't raise food costs compared to other biofuel feedstocks like corn and sugar cane. The company has signed an $850 million deal with a Mexican company BioFields to grow algae, one of the planet's first life forms, that has been trained to convert water, sunlight, and the greenhouse gas carbon dioxide into motor fuel. Paul Woods, Algenol's chief executive, said he's known the technology for decades but that today's record oil prices and rising alarm about global warming make it time to produce the fuel. "It really is a one-two combination that no other company can deliver," Woods told Reuters in an interview this week. Several algae companies are trying to enter the biofuels business by drying and pressing the organisms to make vegetable oil that can be processed into biodiesel. Woods said Algenol will use a process he invented in the 1980s to coax individual algal cells to secrete ethanol. That way, the fuel can be taken directly from the vats where the algae is grown while the organism lives on, using far less energy than drying and pressing the organisms for their oil. Algenol plans to make 100 million gallons of ethanol, about the average annual capacity of one traditional U.S. distillery, in Mexico's Sonoran Desert by the end of the 2009. By the end of 2012, it plans to increase that to 1 billion gallons -- more than 10 percent of current ethanol capacity in the United States, the world's top ethanol producer. In addition to the $850 million BioFields deal, the company has also received about $70 million in funding from investors.

### A2 Blooms

#### Non U---algae blooms now

Schmidt 8/21

(Megan Scmidt is a writer for the Holland Sentinel, 8-21-12, “Algae blooms close Dunton, Holland State Park beaches”, <http://www.hollandsentinel.com/topstories/x1405829540/Algae-blooms-close-Dunton-Holland-State-Park-beaches>)

If the water's green, don't go in. That's what the Ottawa County Health Department is telling beach-goers after issuing a no-body contact advisories on Tuesday for Dunton Park and Holland State Park. Blue-green algae is what causes the green tint seen in these locations in Lake Macatawa. The no-body contact advisory does not include Lake Michigan. Algae blooms usually occur in the summer, because algae need sunlight, nitrogen and phosphorus to grow. The latter two ingredients are found in fertilizers, as well as in animal and human waste. The hot, dry weather this summer has created an environment where algae can thrive, said Randy Rapp, environmental health supervisor for Ottawa County. "The lake is warmer, too, and the lack of rain means we don't get fresh water coming in, like we would normally," Rapp said. "Plus, the water has been clear up until now, which lets all that sunlight through." According to information posted by the health department, Tuesday, algae exposure can cause skin rashes, hives or blisters, according to the health department. Swallowing water can cause abdominal pain, diarrhea and vomiting. Even inhaling water drops from an algae-infested pond or lake can cause runny eyes and nose, a sore throat, asthma-like symptoms or allergic reactions. Rapp said it's difficult to tell how long the algae blooms will stick around. "I wish I could say it'll only be a couple days, but a lot is dependent on rainfall and temperatures," he said. "We have experienced algae in the past, but not for this length of time. It's been at Dunton Park for an especially long time, which is different than normal, because it usually lasts a few days." If you do swim in water you suspect has algae blooms, "towel off immediately," Rapp said. "And as soon as you can, take a nice, soapy shower." Don't let pets swim in or drink from a water source that appears scummy, either. If a pet does swim in water where there may be algae, rinse its body immediately and do not let it lick its fur. Don't irrigate lawns with pond water that looks scummy or has a bad odor.

#### The CP is grown in vats—their bloom evidence assumes photosynthesis

Voosen 11

(Paul Voosen is a writer for Greenwire a news service devoted to coverage of the latest environmental news, 3-29-11, “As Algae Bloom Fades, Photosynthesis Hopes Still Shine”, <http://www.nytimes.com/gwire/2011/03/29/29greenwire-as-algae-bloom-fades-photosynthesis-hopes-stil-54180.html?pagewanted=all>)

Solazyme's success is tied to one fateful decision, said Harrison Dillon, the firm's founder. It ditched photosynthesis. "We grew ponds of algae for about two years," Dillon said. They tried it in translucent reactors, too. But in both situations, he said, "we couldn't come up with a scenario where we weren't making ridiculous assumptions."Solazyme instead cultivates its algae in large, dark vats, feeding them sugar -- a process nearly identical to current ethanol production. In effect, the firm bought into the dominant biofuel system, substituting diesel and jet fuel for ethanol as a final product. (Matching yeast's hyper-efficient conversion of sugar to ethanol is another story.) Given the uncertainty facing its algae peers, Solazyme's choice seems at least a wise short-term decision. The Department of Energy has remained a strong proponent of algae's potential, but as its senior officials have stressed in the past year that potential remains far from being realized.

#### No algae takeover—their evidence is hype

Pollack 10

(Andrew Pollack is a writer for the New York Times, 7-26-10, “Exploring Algae as fuel”, <http://www.nytimes.com/2010/07/26/business/energy-environment/26algae.html?_r=1&pagewanted=all>)

A week earlier, at an industry-sponsored bioenergy conference, David Haberman, an engineer who has worked on an algae project, gave a talk warning of risks. Many scientists, particularly those in the algae business, say the fears are overblown. Just as food crops cannot thrive without a farmer to nourish them and fend off pests, algae modified to be energy crops would be uncompetitive against wild algae if they were to escape, and even inside their own ponds. “Everything we do to engineer an organism makes it weaker,” said Stephen Mayfield, a professor of biology at the [University of California, San Diego](http://topics.nytimes.com/topics/reference/timestopics/organizations/u/university_of_california/index.html?inline=nyt-org), and a co-founder of Sapphire. “This idea that we can make Frankenfood or Frankenalgae is just absurd.” Dr. Mayfield and other scientists say there have been no known environmental problems in the 35 years that scientists have been genetically engineering bacteria, although some organisms have undoubtedly escaped from laboratories. Even Margaret Mellon of the [Union of Concerned Scientists](http://topics.nytimes.com/top/reference/timestopics/organizations/u/union_of_concerned_scientists/index.html?inline=nyt-org), who has been critical of biotech crops, said that if genetically engineered algae were to escape, “I would not lose sleep over it at all.”

#### Suicide genes solve

Pollack 10

(Andrew Pollack is a writer for the New York Times, 7-26-10, “Exploring Algae as fuel”, <http://www.nytimes.com/2010/07/26/business/energy-environment/26algae.html?_r=1&pagewanted=all>)

Dr. Venter’s company, Synthetic Genomics, is getting $300 million from [Exxon Mobil](http://topics.nytimes.com/top/news/business/companies/exxon_mobil_corporation/index.html?inline=nyt-org) to create fuel-producing algae, in part by using synthetic genes. When the two companies cut the ribbon on a new greenhouse here earlier this month, Dr. Venter assured local dignitaries in attendance that no algae would escape. “Nothing will go into the drains, Mr. Mayor,” Dr. Venter said, only half-jokingly. “San Diego is safe.”In the long run, Dr. Venter said, the algae should be given “suicide genes” that would kill them if they escaped the lab or fuel production facility. Some companies are sticking with searching for and breeding natural strains. “Re-engineering algae seems driven more by patent law and investor desire for protection than any real requirement,” said Stan Barnes, chief executive of Bioalgene, which is one of those companies. But Dr. Venter and Mr. Mendez argue that there are huge obstacles to making algae competitive as an energy source and that every tool will be needed to optimize the strains.

### A2 cost

#### Even a simple, open pond system is much more cost-effective than oil

Briggs, ‘4

[Michael, University of New Hampshire Biodiesel Group, “Widescale Biodiesel Production from Algae” Energy Bulletin, 10-3-2004, http://www.unh.edu/p2/biodiesel/article\_alge.html]

In "The Controlled Eutrophication process: Using Microalgae for CO2 Utilization and Agircultural Fertilizer Recycling"3, the authors estimated a cost per hectare of $40,000 for algal ponds. In their model, the algal ponds would be built around the Salton Sea (in the Sonora desert) feeding off of the agircultural waste streams that normally pollute the Salton Sea with over 10,000 tons of nitrogen and phosphate fertilizers each year. The estimate is based on fairly large ponds, 8 hectares in size each. To be conservative (since their estimate is fairly optimistic), we'll arbitrarily increase the cost per hectare by 100% as a margin of safety. That brings the cost per hectare to $80,000. Ponds equivalent to their design could be built around the country, using wastewater streams (human, animal, and agricultural) as feed sources. We found that at NREL's yield rates, 15,000 square miles (3.85 million hectares) of algae ponds would be needed to replace all petroleum transportation fuels with biodiesel. At the cost of $80,000 per hectare, that would work out to roughly $308 billion to build the farms. The operating costs (including power consumption, labor, chemicals, and fixed capital costs (taxes, maintenance, insurance, depreciation, and return on investment) worked out to $12,000 per hectare. That would equate to $46.2 billion per year for all the algae farms, to yield all the oil feedstock necessary for the entire country. Compare that to the $100-150 billion the US spends each year just on purchasing crude oil from foreign countries, with all of that money leaving the US economy. These costs are based on the design used by NREL - the simple open-top raceway pond. Various approaches being examined by the research groups focusing on algae biodiesel range from being the same general system, to far more complicated systems. As a result, this cost analysis is very much just a general approximation.

#### Switching to algae reduces costs and provide income from fertilizers.

Chisti 8

[Yusuf, School of Engineering, Massey University) March 2008 [Trends in Biotechnology](http://www.sciencedirect.com/science/journal/01677799), [Volume 26, Issue 3](http://www.sciencedirect.com/science?_ob=PublicationURL&_tockey=%23TOC%235181%232008%23999739996%23680786%23FLA%23&_cdi=5181&_pubType=J&_auth=y&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=631b77e204856ef9bf4e0eb5b4aab8be), Pages 126-131]

The algal broth produced in the biomass production stage needs to be further processed to recover the biomass [[9]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib9#bib9). The water and residual nutrients recovered at this stage can be recycled to the biomass-cultivation stage ([Figure 1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#fig2#fig2)). The concentrated biomass paste is extracted with a water-immiscible solvent to recover algal oil, which can then be converted to biodiesel using already existing methods [1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bbib1) Y. Chisti, Biodiesel from microalgae, *Biotechnol. Adv.* 25 (2007), pp. 294–306. [Article](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T4X-4N20704-1&_user=4420&_coverDate=06%2F30%2F2007&_fmt=full&_orig=search&_cdi=4986&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=ece85eec18bf4e69d5a7a1b715b57dd9&ref=full) | [icon_pdfPDF (387 K)](http://www.sciencedirect.com/science?_ob=MiamiImageURL&_imagekey=B6T4X-4N20704-1-1&_cdi=4986&_user=4420&_check=y&_orig=search&_coverDate=06%2F30%2F2007&view=c&wchp=dGLbVtb-zSkzS&md5=a4469afcface1f08d795a72695768390&ie=/sdarticle.pdf) | [View Record in Scopus](http://www.sciencedirect.com/science?_ob=RedirectURL&_method=outwardLink&_partnerName=655&_targetURL=http%3A%2F%2Fwww.scopus.com%2Fscopus%2Finward%2Frecord.url%3Feid%3D2-s2.0-33947617349%26partnerID%3D10%26rel%3DR3.0.0%26md5%3De30ae19fb5acdb9b5e7eb4fa7de1e94a&_acct=C000059607&_version=1&_userid=4420&md5=225e2a334a46376bbdfe3ef53f0fce56) | [Cited By in Scopus (18)](http://www.sciencedirect.com/science?_ob=RedirectURL&_method=outwardLink&_partnerName=656&_targetURL=http%3A%2F%2Fwww.scopus.com%2Fscopus%2Finward%2Fcitedby.url%3Feid%3D2-s2.0-33947617349%26partnerID%3D10%26rel%3DR3.0.0%26md5%3De30ae19fb5acdb9b5e7eb4fa7de1e94a&_acct=C000059607&_version=1&_userid=4420&md5=583830608c0d0fb6793c9234f6126d36)[[1]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib1#bib1). The feasibility of oil extraction for microalgal biomass has been previously demonstrated [[6]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib6#bib6) and [[10]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib10#bib10). The extraction solvent (e.g. hexane) is expected to be recovered and recycled. The biomass residue that remains after extraction of oil could be used partly as high-protein animal feed and, possibly, as a source of small amounts of other high-value microalgal products [[5]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib5#bib5), [[11]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib11#bib11) and [[12]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib12#bib12). In both scenarios, the revenue from selling the biomass residues could defray the cost of producing biodiesel. However, the majority of algal biomass residue from oil extraction is expected to undergo anaerobic digestion to produce biogas. This biogas will serve as the primary source of energy for most of the production and processing of the algal biomass. The generation of surplus energy is expected and this could be sold to grid to further improve the economics of the integrated process. Additional income could come from the sale of nutrient-rich fertilizer and irrigation water that would be produced during the anaerobic digestion stage ([Figure 1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#fig2#fig2)).

### A2 Expensive

#### Incentives make algae cost competitive

ARCWire.Org 2/26/08 (nqa, “Is Algae the Bio-Fuel of the Future?,” pg online @

With respect to costs, commercial algal fuel naysayers argue that it will be very difficult to compete economically, with billions of dollars invested at the taxpayer's expense in 'first generation fuels,' not to mention the enormous capital costs associated with creating a facility to grow algae. “Although capital costs are much higher than first generation biofuels,” according to Michael Briggs, laboratory manager at the University of New Hampshire Physics Department, “The ongoing processing costs could be much lower for algae since you don't have to drive a tractor over a field, or water a crop or rotate crops." Briggs, along with other algae researchers, are confident that a combination of rising oil costs and government environmental and energy incentives will improve the viability of algae as a fuel source. In fact, a research group from Utah State, claim their algae bioreactor’s biodiesel could become economically feasible as early as 2009.

#### Byproducts could be sold as animal feed—reduces the cost

Yusuf Chisti (School of Engineering, Massey University) March 2008 [Trends in Biotechnology](http://www.sciencedirect.com/science/journal/01677799), [Volume 26, Issue 3](http://www.sciencedirect.com/science?_ob=PublicationURL&_tockey=%23TOC%235181%232008%23999739996%23680786%23FLA%23&_cdi=5181&_pubType=J&_auth=y&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=631b77e204856ef9bf4e0eb5b4aab8be), Pages 126-131

The algal broth produced in the biomass production stage needs to be further processed to recover the biomass [[9]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib9#bib9). The water and residual nutrients recovered at this stage can be recycled to the biomass-cultivation stage ([Figure 1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#fig2#fig2)). The concentrated biomass paste is extracted with a water-immiscible solvent to recover algal oil, which can then be converted to biodiesel using already existing methods [1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bbib1) Y. Chisti, Biodiesel from microalgae, *Biotechnol. Adv.* 25 (2007), pp. 294–306. [Article](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T4X-4N20704-1&_user=4420&_coverDate=06%2F30%2F2007&_fmt=full&_orig=search&_cdi=4986&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=ece85eec18bf4e69d5a7a1b715b57dd9&ref=full) | [icon_pdfPDF (387 K)](http://www.sciencedirect.com/science?_ob=MiamiImageURL&_imagekey=B6T4X-4N20704-1-1&_cdi=4986&_user=4420&_check=y&_orig=search&_coverDate=06%2F30%2F2007&view=c&wchp=dGLbVtb-zSkzS&md5=a4469afcface1f08d795a72695768390&ie=/sdarticle.pdf) | [View Record in Scopus](http://www.sciencedirect.com/science?_ob=RedirectURL&_method=outwardLink&_partnerName=655&_targetURL=http%3A%2F%2Fwww.scopus.com%2Fscopus%2Finward%2Frecord.url%3Feid%3D2-s2.0-33947617349%26partnerID%3D10%26rel%3DR3.0.0%26md5%3De30ae19fb5acdb9b5e7eb4fa7de1e94a&_acct=C000059607&_version=1&_userid=4420&md5=225e2a334a46376bbdfe3ef53f0fce56) | [Cited By in Scopus (18)](http://www.sciencedirect.com/science?_ob=RedirectURL&_method=outwardLink&_partnerName=656&_targetURL=http%3A%2F%2Fwww.scopus.com%2Fscopus%2Finward%2Fcitedby.url%3Feid%3D2-s2.0-33947617349%26partnerID%3D10%26rel%3DR3.0.0%26md5%3De30ae19fb5acdb9b5e7eb4fa7de1e94a&_acct=C000059607&_version=1&_userid=4420&md5=583830608c0d0fb6793c9234f6126d36)[[1]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib1#bib1). The feasibility of oil extraction for microalgal biomass has been previously demonstrated [[6]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib6#bib6) and [[10]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib10#bib10). The extraction solvent (e.g. hexane) is expected to be recovered and recycled. The biomass residue that remains after extraction of oil could be used partly as high-protein animal feed and, possibly, as a source of small amounts of other high-value microalgal products [[5]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib5#bib5), [[11]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib11#bib11) and [[12]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib12#bib12). In both scenarios, the revenue from selling the biomass residues could defray the cost of producing biodiesel. However, the majority of algal biomass residue from oil extraction is expected to undergo anaerobic digestion to produce biogas. This biogas will serve as the primary source of energy for most of the production and processing of the algal biomass. The generation of surplus energy is expected and this could be sold to grid to further improve the economics of the integrated process. Additional income could come from the sale of nutrient-rich fertilizer and irrigation water that would be produced during the anaerobic digestion stage ([Figure 1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#fig2#fig2)).

#### Even a simple, open pond system is much more cost-effective than oil

Michael Briggs, Physics @ University of New Hampshire, 04

<http://www.unh.edu/p2/biodiesel/article_alge.html>

In "The Controlled Eutrophication process: Using Microalgae for CO2 Utilization and Agircultural Fertilizer Recycling"3, the authors estimated a cost per hectare of $40,000 for algal ponds. In their model, the algal ponds would be built around the Salton Sea (in the Sonora desert) feeding off of the agircultural waste streams that normally pollute the Salton Sea with over 10,000 tons of nitrogen and phosphate fertilizers each year. The estimate is based on fairly large ponds, 8 hectares in size each. To be conservative (since their estimate is fairly optimistic), we'll arbitrarily increase the cost per hectare by 100% as a margin of safety. That brings the cost per hectare to $80,000. Ponds equivalent to their design could be built around the country, using wastewater streams (human, animal, and agricultural) as feed sources. We found that at NREL's yield rates, 15,000 square miles (3.85 million hectares) of algae ponds would be needed to replace all petroleum transportation fuels with biodiesel. At the cost of $80,000 per hectare, that would work out to roughly $308 billion to build the farms. The operating costs (including power consumption, labor, chemicals, and fixed capital costs (taxes, maintenance, insurance, depreciation, and return on investment) worked out to $12,000 per hectare. That would equate to $46.2 billion per year for all the algae farms, to yield all the oil feedstock necessary for the entire country. Compare that to the $100-150 billion the US spends each year just on purchasing crude oil from foreign countries, with all of that money leaving the US economy. These costs are based on the design used by NREL - the simple open-top raceway pond. Various approaches being examined by the research groups focusing on algae biodiesel range from being the same general system, to far more complicated systems. As a result, this cost analysis is very much just a general approximation.

#### The Bi-Products of the Algae Fuel Development Process Can Be Sold to Reduce Production Costs and Save Companies Money

Yusuf Chisti (School of Engineering, Massey University) March 2008 [Trends in Biotechnology](http://www.sciencedirect.com/science/journal/01677799), [Volume 26, Issue 3](http://www.sciencedirect.com/science?_ob=PublicationURL&_tockey=%23TOC%235181%232008%23999739996%23680786%23FLA%23&_cdi=5181&_pubType=J&_auth=y&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=631b77e204856ef9bf4e0eb5b4aab8be), Pages 126-131

The algal broth produced in the biomass production stage needs to be further processed to recover the biomass [[9]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bib9#bib9). The water and residual nutrients recovered at this stage can be recycled to the biomass-cultivation stage ([Figure 1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#fig2#fig2)). The concentrated biomass paste is extracted with a water-immiscible solvent to recover algal oil, which can then be converted to biodiesel using already existing methods [1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bbib1) Y. Chisti, Biodiesel from microalgae, *Biotechnol. Adv.* 25 (2007), pp. 294–306. [Article](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6T4X-4N20704-1&_user=4420&_coverDate=06%2F30%2F2007&_fmt=full&_orig=search&_cdi=4986&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=ece85eec18bf4e69d5a7a1b715b57dd9&ref=full) | [PDF (387 K)](http://www.sciencedirect.com/science?_ob=MiamiImageURL&_imagekey=B6T4X-4N20704-1-1&_cdi=4986&_user=4420&_check=y&_orig=search&_coverDate=06%2F30%2F2007&view=c&wchp=dGLbVtb-zSkzS&md5=a4469afcface1f08d795a72695768390&ie=/sdarticle.pdf) | [View Record in Scopus](http://www.sciencedirect.com/science?_ob=RedirectURL&_method=outwardLink&_partnerName=655&_targetURL=http%3A%2F%2Fwww.scopus.com%2Fscopus%2Finward%2Frecord.url%3Feid%3D2-s2.0-33947617349%26partnerID%3D10%26rel%3DR3.0.0%26md5%3De30ae19fb5acdb9b5e7eb4fa7de1e94a&_acct=C000059607&_version=1&_userid=4420&md5=225e2a334a46376bbdfe3ef53f0fce56) | [Cited By in Scopus (18)](http://www.sciencedirect.com/science?_ob=RedirectURL&_method=outwardLink&_partnerName=656&_targetURL=http%3A%2F%2Fwww.scopus.com%2Fscopus%2Finward%2Fcitedby.url%3Feid%3D2-s2.0-33947617349%26partnerID%3D10%26rel%3DR3.0.0%26md5%3De30ae19fb5acdb9b5e7eb4fa7de1e94a&_acct=C000059607&_version=1&_userid=4420&md5=583830608c0d0fb6793c9234f6126d36)[[1]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#bib1#bib1). The feasibility of oil extraction for microalgal biomass has been previously demonstrated [[6]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bib6#bib6) and [[10]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bib10#bib10). The extraction solvent (e.g. hexane) is expected to be recovered and recycled. The biomass residue that remains after extraction of oil could be used partly as high-protein animal feed and, possibly, as a source of small amounts of other high-value microalgal products [[5]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bib5#bib5), [[11]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bib11#bib11) and [[12]](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752" \l "bib12#bib12). In both scenarios, the revenue from selling the biomass residues could defray the cost of producing biodiesel. However, the majority of algal biomass residue from oil extraction is expected to undergo anaerobic digestion to produce biogas. This biogas will serve as the primary source of energy for most of the production and processing of the algal biomass. The generation of surplus energy is expected and this could be sold to grid to further improve the economics of the integrated process. Additional income could come from the sale of nutrient-rich fertilizer and irrigation water that would be produced during the anaerobic digestion stage ([Figure 1](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6TCW-4RNK3VP-1&_user=4420&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059607&_version=1&_urlVersion=0&_userid=4420&md5=6965dcc238fd7f8ca8042232963d5752#fig2#fig2)).

### A2 farm shocks

#### Algae can replace all US fuels and avoid shocks in farm prices.

AFP, ‘8

[“As planet swelters, are algae unlikely savior?” July 10, 2008, http://afp.google.com/article/ALeqM5ir4Mg2eQ23RPDhBkH2BnulZai-ZA]

Compared with the increasingly controversial first-generation biofuels made from food crops like sunflowers, rapeseed, wheat and corn, microalgae have the huge advantage of not encroaching on agricultural land or affecting farm prices, and can be grown whenever there's sunlight. They also can yield far more oil than other oleaginous plants grown on land. "To cover US fuel needs with biodiesel extracted from the most efficient terrestrial plant, palm oil, it would be necessary to use 48 percent of the country's farmland," according to a recent study by the Oslo-based Centre for International Climate and Environmental Research. "The United States could potentially replace all of its petrol-based automobile fuel by farming microalgae on a surface corresponding to five percent of the country's farmland," the study added.

### A2 Land/Resource Use

#### Algal Biodiesel Is Sustainable – Resources For Production Wouldn’t Be A Problem

Sheehan et al, 98 (John Sheehan Biotechnology Center for Fuels and Chemicals National Renewable Energy Laboratory, Terri Dunahay, John Benemann, Paul Roessler, National Renewable Energy Laboratory, “A Look Back at the U.S. Department of Energy’s Aquatic Species Program—Biodiesel from Algae,” <http://www1.eere.energy.gov/biomass/pdfs/biodiesel_from_algae.pdf>

The ASP regularly revisited the question of available resources for producing biodiesel from microalgae. This is not a trivial effort. Such resource assessments require a combined evaluation of appropriate climate, land and resource availability. These analyses indicate that significant potential land, water and CO2 resources exist to support this technology. Algal biodiesel could easily supply several “quads” of biodiesel—substantially more than existing oilseed crops could provide. Microalgae systems use far less water than traditional oilseed crops. Land is hardly a limitation. Two hundred thousand hectares (less than 0.1% of climatically suitable land areas in the U.S.) could produce one quad of fuel. Thus, though the technology faces many R&D hurdles before it can be practicable, it is clear that resource limitations are not an argument against the technology. And, it Doesn’t Take Much Land to Produce it – Can Sustain Fuel for the Entire Planet on a Small Amount of Land Gressel in ‘0 (Plant Sciences, Weizmann Institute of Science “Transgenics are imperative for biofuel crops,” *Plant Science*, March, pg Science Direct //greenhill-ef) Algae in ponds can be far more efficient than higher plants in capturing solar energy, more so in bioreactors. The US Department of Energy funded a large international project on microalgae for biofuel production that ceased operations a decade ago [[135]](http://www.sciencedirect.com.ezproxy1.lib.asu.edu/science?_ob=ArticleURL&_udi=B6TBH-4R7NPW3-1&_user=56861&_coverDate=03%2F31%2F2008&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059542&_version=1&_urlVersion=0&_userid=56861&md5=6e7071442a5cbac1090518aa68fbe3b7" \l "bbib135) J. Sheehan, T. Dunahay, J. Benemann, P. Roessler, A Look Back at the U.S. Department of Energy's Aquatic Species Program—Biodiesel from Algae. Prepared for the U.S. Department of Energy's Office of Fuels Development, National Renewable Energy Laboratory, Golden, Colorado, 1998.[[135]](http://www.sciencedirect.com.ezproxy1.lib.asu.edu/science?_ob=ArticleURL&_udi=B6TBH-4R7NPW3-1&_user=56861&_coverDate=03%2F31%2F2008&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059542&_version=1&_urlVersion=0&_userid=56861&md5=6e7071442a5cbac1090518aa68fbe3b7#bib135#bib135). The project achieved sporadic maximum yields of more than one hundred times greater than oil palm (per unit area) and oil palm is among the most efficient of conventional crops (see [Table 1](http://www.sciencedirect.com.ezproxy1.lib.asu.edu/science?_ob=ArticleURL&_udi=B6TBH-4R7NPW3-1&_user=56861&_coverDate=03%2F31%2F2008&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059542&_version=1&_urlVersion=0&_userid=56861&md5=6e7071442a5cbac1090518aa68fbe3b7" \l "tbl1#tbl1)). If algal production could be scaled up industrially, less than 6 million hectares would be necessary worldwide to meet current fuel demands, amounting to less than 0.4% of arable land, an achievable goal for global agriculture [[135]](http://www.sciencedirect.com.ezproxy1.lib.asu.edu/science?_ob=ArticleURL&_udi=B6TBH-4R7NPW3-1&_user=56861&_coverDate=03%2F31%2F2008&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000059542&_version=1&_urlVersion=0&_userid=56861&md5=6e7071442a5cbac1090518aa68fbe3b7" \l "bib135#bib135). Additionally, many of the very efficient oil producer organisms are marine. Thus ponds near the world's seas could conceivably produce sufficient biofuels, without needing or affecting fresh water supplies, which are becoming limiting.

### A2 infrastructure shortage

#### Companies will jump on board if there is support.

All Business, ‘8

[<http://www.allbusiness.com/energy-utilities/oil-gas-industry-oil-processing/11462810-1.html>, July 1, 2008]

ConocoPhillips said Tuesday it has entered into a research partnership with the Colorado state Center for Biorefining and Biofuels to develop new ways to convert biomass into low-carbon transportation fuels. Stephen Brand, a CoP senior vice president for technology, described the agreement as a $5 million, multi-year sponsored project that will involve converting algae into renewable fuel. Colorado's Center for Biorefining and Biofuels is tasked with trying to develop new ways to convert biomass into low-carbon transportation fuels and is part of the Colorado Renewable Energy Collaboratory, a joint venture among the state's universities and the National Renewable Energy Laboratory in Golden. Houston-based CoP, the third-largest integrated energy company and the second-largest refiner in the United States, has plans to build a technology research facility and global learning center in Louisville, Colo. expected to open in 2012. This is just the latest in many companies jumping on the algae to ethanol train. Last week, EBN reported that Algenol signed an $850 million deal with Mexican company BioFields with plans to make ethanol from algae (6/17/08). Algenols plan is to grow a primordial green soup that will not raise food prices compared to other biofuel feedstocks such as corn and sugar cane.

### A2 Large Scale Production Turns

#### A combination of open-ponds, and indoor closed production of algae solves your turns to large-scale production

Hu et al 08 (Qiang Hu, Department of Applied Biological Sciences, Arizona State University, Milton Sommerfeld1, Eric Jarvis, National Renewable Energy Laboratory Maria Ghirardi2, Matthew Posewitz3, Michael Seibert2 and Al Darzins, Department of Chemistry and Geochemistry, Colorado School of Mines, Plant Journal, February, “Microalgal triacylglycerols as feedstocks for biofuelproduction: perspectives and advances,”

(6) Developing innovative large-scale culture systems that will enable selected algal strains to achieve high and sustained growth rates and oil yields is essential to developing an algal-based biofuel industry. A comprehensive literature review (Hu et al., 2006) indicates that open raceway ponds can be cost-effective for a limited number of algal species in producing protein- or carotenoid-rich biomass, but are less effective or sustainable for production of oil-rich biomass due to the inherent technical constrains of current pond designs. Although substantial increases in biomass and oil production have been achieved in closed photobioreactors of various configurations, high capital and operational costs associated with the tested closed photobioreactors may prevent their application as a commercial production system. Innovative concepts for algal culture systems that will increase the production of oil-rich biomass while at the same time reducing the cost are needed. A hybrid culture system concept that integrates an open raceway system and a closed photobioreactor in various configurations may provide a path forward to commercialization of an industry based on algal lipid biosynthesis. Further research efforts should also be focused on the reduction of costs and energy consumption associated with the downstream processing of algal biomass, including developing more efficient processes for harvesting and de-watering. Lipid extraction from algal biomass represents another major task that will also require either modified or new approaches as processing algal biomass for oil introduces challenges that have not been previously encountered with oil seeds.

### A2 long timeframe

#### Large scale production will be available within a year

Biofuels Digest May 30 2008 "Jury still out on algae systems, says Sandia National Lab researcher; algae round-up”

In Washington state, algae start-up Bionavitas said that it will take up to four years to reach commercial levels of production,but that its waste water treatment business is developing faster. In Florida, Neptune Industry will use a "floating sock" algae system, based in a rock quarry to produce algae for biodiesel.The facility will also use fish waste to accelerate the algae growingprocess. The Florida City site is funded by a Florida Farm to Fuelgrant, and utilizes car-bon dioxide tanks to provide CO2 to the algae,and uses its "floating sock" system to rotate the algae to provide CO2,sunlight and nutrients to the entire system. Neptune's owners projectedyields of as much as 10,000 gallons per acre from their process. In Florida, PetroAlgae said that it hoped to reach its commercial production stage next year,as algae producers begin to differentiate over varying methods ofgetting past the algae "shade wall" and other issues in achiev-ingcommercial scale. New Zealand's Aquaflow said that it has developed a scalable methodfor producing and harvest-ing algae in the wild, and envisionedexpanding to a series of 1,000 acre facilities in the US and othercountries. A re-search team from the University of Texas has developed a new blue-green algae (cyanobacteria) that secretes a soft cellulose, glucose and sucrose.The team told Science Daily that the microbe "could provide asignificant portion of the nation's transportation fuel if production can be scaled up." The cyanobacteria is grown from sunlight and saltywater at facilities on non-agricultural land. The team said that thecellulose is a soft, gel-like type that is easy to break down, and thatthe microbes secrete the sugars and cellulose, making it possibly tocontinually harvest biofuels feedstock without destroying organisms andusing powerful enzymes to extract sugars. The University of New Hampshire Biodiesel Group said it would cost $308 billion to build enough algae farms to replace gasoline with algae-based biodiesel,and $47 bil-lion per year to run the production system for 140 billiongallons, or $0.34 per gallon before transportation and retail costs.The National Renewable Energy Laboratory said it would take an algaefield of up to 15,000 square miles. Produc-ers and researchers aredisagreeing over the wisdom of closed bioreactors versus open algaeponds. Proponents of reac-tors point to the control of the process,while companies such as Aquaflow Bionomic point to the affordability ofopen ponds. In California, tests on Soladiesel from Solazyme were conducted by the Southwest Research Instituteconcluded that algae-based biodiesel has superior performance undercold weather conditions than biodiesel derived from other feedstocks. The National Algae Associationheld its first meeting, which sold out as hundreds of algae investorsand pro-ducers convened in Texas in April to discuss new ventures, andpaths to profitability. In the Netherlands, AlgaeLink announced a new process for extracting algae oilwithout using chemicals, drying or an oil press. The company said thatits patent-pending technique uses 26 kilowatts of power to produce12,000 gallons of algae oil per hour, with a yield of 50 percent fromthe initial algae paste. In Texas, thestate's Emerging Technology Fund will provide $4 million to TexasAgriLife Research and General Atomics to conduct microalgae research and development. In Virginia, research-ers at Old Dominion University have successfully piloted a project to produce biodiesel feedstock by growing algae at municipal sewage treatment plants.The researchers hope that these algae production techniques could leadto reduced emissions of nitrogen, phosphorusand carbon dioxide intothe air and surrounding bodies of water. The pilot project is producingup to 70,000 gallons of biodiesel per year. In Minnesota, XcelEnergy has pledged $150,000 to assist in fund-ing an algae-to-biodieselresearch project sponsored by the University and the MetropolitanCouncil. The grant is a fol-low-on to more than $4.5 million givento five other University of Minnesota projects from the Xcel Energy

### A2 privates solve

#### Government intervention is necessary to spur algae development – start-up costs are too high

Times June 5 2008 “What's green, slimy and could save the Planet?”

Algae farms could be the next big thing in energy creation - but we need huge investment to spur their growth Sorry, Africa, but I need your next meal to run my pick-up down to the mall. Just shove your corn in my tank, will you? This thing only does 20 miles to the gallon. Don't blame me, blame all those middle-class Indians and Chinese who want to live like us. They're the reason food prices are rising. What, you're hungry? Can't you call the UN? The moral dimensions to food and energy prices, and the links between them, are becoming inescapable. There is huge resentment about biofuels at this week's World Food Summit, even though prosperity is the main reason for higher food prices. There was outrage in India recently, when Condoleezza Rice appeared to blame its middle-class for costlier food. Why shouldn't we eat the same as you, asked Indian MPs. We're still thinner. And why should the West suck up prime agricultural land to grow subsidised biofuels just to keep driving cheaply? It's bad enough that a high oil price makes fertiliser and tractor fuel more expensive. It's utterly irresponsible to burn food to make fuel. The same blame game is being played with climate change. You've put more carbon dioxide into the atmosphere than we have, say the Chinese. Don't tell us to cool it. Britain, according to Jim Hansen of Nasa, has a greater stock of carbon dioxide on its conscience than any other country, since it industrialised first. You lot started the first industrial revolution, a Brazilian once raged to me. Why can't you start the second? Maybe we can. While governments wrangle, entrepreneurs and scientists are in a race to reinvent energy, including biofuels. Dot-com billionaires such as Vinod Khosla, of Sun Microsystems, and Paul Allen, of Microsoft, are ploughing their fortunes back into schemes that probably sound as crazy as Google once did. Giant mirrors are tracking the Sun in New Mexico, powered by microprocessors to concentrate the rays. Enzymes are breaking down the non-edible parts of plants to make fuel in Canada. Algae, that green stuff in your pond, is being used to make biodiesel in New Zealand. Algae can grow almost anywhere, even in deserts. And some species grow so fast that they double in size three or four times a day. According to Fred Krupp, author of the excellent Earth: The Sequel, it would take only 47 million acres of algae to produce fuel for half of America's cars, compared with 1.5 billion acres of soy beans. I never knew pondlife was so exciting. Algae also eat carbon dioxide at a similarly prolific rate. That makes them multitasking miracle-workers: both a fuel and a way to clean up power-plant emissions. Not surprisingly, several companies are now trying to move from relatively small algae beds to industrial scale. Solar is another example where science and venture capital converge. Last year I spent a frustrating afternoon with physicists at Imperial College who patiently explained how to make thin films, fabrics, even paint, capable of cap-turing energy from sunlight. The technology was beyond me. But I did grasp the economics. Making thin films from synthetic materials will dramatically reduce the cost of solar technology. There are still technical problems with many technologies. With algae, it is how to harvest at scale. With solar, it is how to store the energy efficiently. But the biggest challenge is no longer in the lab. It is lack of capital to get these ideas to scale. Successful internet companies such as Google were launched with millions of dollars. But building solar power plants or biofuel refineries requires hundreds of millions. That means investors taking much bigger risks, in a sector where profits are enormously influenced by government regulation. What's the answer? You can subsidise particular industries, as Japan and Germany have done with solar. But that means picking winners. Or you can put a price on carbon dioxide. That changes the way that companies compare the costs of building a dirty coal plant with, say, a clean solar one. The EU has already put a low price on carbon dioxide, which it is gradually ratcheting up. John Doerr, the legendary investor who first backed Google and Amazon, has said that a similar cap on carbon in America would make thin-film solar technology competitive with conventional electric-ity in only two years. Which is why historians may come to see Monday night as a turning point.

#### Private companies alone aren’t enough to make algae viable in the short term—only government incentives solves

SNS (States News Service) August 27 2008 “Whether Brown Or Red, Algae Can Produce Plenty Of Green Fuel”

Having studied the physiology of algae for more than 30 years, Rose Ann Cattolico is convinced the plant life found in oceans and ponds can be a major source of environmentally friendly fuels for everything from cars and lawn mowers to jet airplanes.¶ She's not the only one. Recently Allied Minds, an investment company that works with universities to commercialize early-stage technology, invested in the University of Washington biology professor's work, forming a startup company called AXI. "People don't realize how many types of algae there are -- from single cells to large kelp -- and each one develops differently," Cattolico said. "What we're trying to do is choose the best of the best, the ones that produce the right lipids for a particular type of fuel." AXI won't be in the business of making fuel. Instead, it will work with biofuel producers to develop strains of algae that produce just the right lipids, or oils, for the fuel that the producer wants to make. The methods will not employ genetic modification, Cattolico said. "It's not like creating a widget. It's a dynamic process that will change all the time," she said. Unlike many agriculturally important crops such as corn that produce starch as a byproduct of photosynthesis, some algae make lipids. One type of algae might produce oil appropriate for a motor vehicle. Another might be useful for home heating oil. Yet another might produce lipids just right for powering an airliner across the Pacific Ocean. Some strains could produce oil useful for other products, such as the omega 3 fatty acids that make fish oil dietary supplements so popular. Algae grow rapidly and do not require the use of productive farmland. Algae also can use various nutritional sources, including wastewater, Cattolico said. A variety of factors made this an opportune time to form AXI, said Erick Rabins, the company's interim manager and vice president of Allied Minds, based in Quincy, Mass. Escalating costs for oil (from about $27 a barrel to more than $100 in five years), rising demand for alternative fuels, the effects of climate change, and growing concern about using foods such as corn and soybeans as fuel stock are making fuel from algae a much more attractive option. But that won't necessarily translate into rapid development of algae-based fuels, Rabins said. Entire infrastructures, from specialized growing facilities to processing plants, will have to be created, and that will come only after potential producers see the value and make the investment. He speculated that it could take 10 to 25 years before algae-based biofuel is readily available to the public, though specialty uses could appear sooner. "The most optimistic assessment that I've heard is that it could be six to eight years before there's something that's useable, but the tools and techniques to make it possible are being created right now," he said. Details of the agreement between Allied Minds and UW TechTransfer to commercialize Cattolico's synthesis methods were not disclosed. The company was drawn to her work, Rabins said, because she has spent so many years making detailed analyses of many different strains of algae, in essence creating a reference database. Cattolico began studying algae almost by accident. As a master's degree student she worked with terrestrial plant pollen. But it turned out she was allergic to pollen and her physician advised her to change fields, so for her doctoral work she began studying chlorophyll-containing structures within the cells of algae. That was in 1973, right at the end of another major societal spasm over fuel shortages and high gas prices. As gasoline became more plentiful again, demands for finding alternative fuel sources grew dimmer and "all of the money for research dried up," Cattolico said. In the current fuel debate, Cattolico readily points to the merits of algae-based biofuel. But she believes it is only a part of the answer to high fuel prices and replacing current fuels with climate-friendlier alternatives. She would like to see a broad commitment by government and industry to quickly develop the alternate energy sources needed to reduce environmental problems, increase national security and hold down costs. "What we need is a Manhattan Project for fuel. If we can get a Manhattan Project for fuel, it won't take 25 years," Cattolico said.

### A2 No Facilities

#### Infrastructure Development Now – Companies are Willing to Jump On-Board Ethanol and Biodiesel News

All Business July 1 2008 <http://www.allbusiness.com/energy-utilities/oil-gas-industry-oil-processing/11462810-1.html>

ConocoPhillips said Tuesday it has entered into a research partnership with the Colorado state Center for Biorefining and Biofuels to develop new ways to convert biomass into low-carbon transportation fuels. Stephen Brand, a CoP senior vice president for technology, described the agreement as a $5 million, multi-year sponsored project that will involve converting algae into renewable fuel. Colorado's Center for Biorefining and Biofuels is tasked with trying to develop new ways to convert biomass into low-carbon transportation fuels and is part of the Colorado Renewable Energy Collaboratory, a joint venture among the state's universities and the National Renewable Energy Laboratory in Golden. Houston-based CoP, the third-largest integrated energy company and the second-largest refiner in the United States, has plans to build a technology research facility and global learning center in Louisville, Colo. expected to open in 2012. This is just the latest in many companies jumping on the algae to ethanol train. Last week, EBN reported that Algenol signed an $850 million deal with Mexican company BioFields with plans to make ethanol from algae (6/17/08). Algenols plan is to grow a primordial green soup that will not raise food prices compared to other biofuel feedstocks such as corn and sugar cane.

### A2 No Light

#### An organic compound can be added to the algae to increase the production

Nikkei Weekly June 2 2008 “Algae looking slick as green oil source,

The Watanabe research team looked at Botryococcus from various lakes and marshes throughout Japan before find-ing a strain of algae with a good balance producing oil as about 45% of dry weight. If the algae are left to proliferate only through photosynthesis, growth will be slow in those parts of the tank where light does not reach. In fact, the yield tops out at around 2g per liter. However, when organic compounds are added to the liquid, the yield can be boosted above 5g. Pure glucose works great as a nutrient, but it is expensive. Luckily, the Watanabe group determined that a glucose solution diluted with domestic wastewater also works well.

### A2 NREL Proves It Won’t Work

#### A lot has changed since the nrel project was shut down—it can be viable now with more investments

Paul Dickerson (Chief Operating Officer California; EERE Information Center) November 14 2007 <http://www.eere.energy.gov/news/speeches/2007-11-14_algae.cfm>

But, as many of you know, that program was ended in 1996, primarily due to costs and the lack of technology which could make "algae diesel" competitive with petroleum diesel. Those strains, though, which now reside at the University of Hawaii under Mark Huntley's care, have continued to serve as the bedrock of evidence for algae fuels-related research. Today, it's hard not to get excited about algae's potential. Its basic requirements are few: CO2, sun, and water. As you know, algae can flourish in non-arable land or in dirty water, and when it does flourish, its potential oil yield per acre is unmatched by any other terrestrial feedstock. In fact, it could be 30 to 100 times more productive. And, my friends, with that kind of promise, we can start to expand the realm of possibilities to include some ambitious applications, like a deployable algae system our military could use to fuel their jets overseas, or an algae farm in the middle of the ocean so energy-starved places like Hawaii could develop, meet their own needs, and trade carbon credits. Clearly, some key challenges remain, not the least of which is discovering a method to extract enough lipids from an algae strain so the process can become economically viable. Algae contamination in large scale facilities is also potentially a challenging deployment issue. But there are reasons for hope. A lot has changed since the DOE terminated the algae program. Biotechnology capabilities have radically increased. Ethanol forecasts have doubled, bringing its cost more in line with biodiesel. And petroleum refiners are now processing biomass-derived lipids, meaning that lipids could be converted to green diesel using existing refinery capital. In a bid to kick start our study of algae's possibilities, NREL last month teamed up with Chevron to collaborate on the research of algae strains. The agreement is a pivotal step to create a pathway to commercialization for algae.

#### New developments mean it will be economically feasible in the future

Dallas Kachan Cleantech Group 2006

<http://media.cleantech.com/459/biofuel-from-algae-on-horizon-say-exper>

Detractors of biofuel from algae point to a 328-page U.S. National Renewable Energy Lab (NREL) report from 1998, from which some concluded that biofuel from algae wouldn't be economically feasible. But panelists argued that much has changed since the report was written, and that the costs of algae production, much like other technologies over time, have dropped. "The economics have changed. When the report was written, oil was at $15 a barrel. They were also assuming manufacturing techniques for biodiesel that were state of the art in 1996," said Tobias of Imperium Renewables. And there's been innovation throughout the value chain in the eight years since the report was written, vendors argued. "We actually feel very good about where our results are going," said GreenFuel's Bullock.

#### A lot has changed since the nrel report

Rich Hilt (Venture Capitalist, Industry Expert, and Writer for Venture Beat) January 24 2007 “The new, old alternative fuel — Algae?,” pg online @ http://venturebeat.com/2007/01/24/the-new-old-alternative-fuel-algae

Putting this in perspective, during the 80s and early 90s, the National Renewable Energy Laboratory (NREL) found algae that produced the equivalent of 1,000 • 5,000 gals/acre/yr of biodiesel in their lab (see NREL info here; downloads Pdf). The field of biology has changed greatly since NREL worked on the problem. If over the next 5 to 10 years NRELs results can be reproduced outside of the lab, and extended to the 10,000 • 15,000 gal/acre/yr that some biologists think can be achieved, it presents a formidable challenge to the other biofuels.

### A2 Slow/Needs Replenishment

#### Algae Solves Quickly, And Doesn’t Require Nourishment

Carlsen (biodiesel expert for Greaseworks.org) December 27 2006 “[Want alternative energy? Try pond scum](http://www.greaseworks.org/modules.php?op=modload&name=News&file=article&sid=308&mode=thread&order=0&thold=0),” <http://www.greaseworks.org/modules.php?op=modload&name=News&file=article&sid=308&mode=thread&order=0&thold=0>

Mounting concern about U.S. dependence on foreign oil and about global warming is causing a surge of interest and investment in biomass, hydrogen, solar power and other alternative energy sources. But bubbling beneath the surface of this wave--in more ways than one--is a technology that, while lacking an existing market or powerful lobby to advance its profile, may soon emerge as the most promising source of portable liquid fuels and that can offer unique environmental benefits to the electrical generation industry. We are talking pond scum, or algae, a plant that for decades has been prized as a possible commodity crop based on its unparalleled ability to photosynthesize solar energy into plant biomass for food. Unlike most plants, algae shares characteristics of bacteria, and its photosynthetic machinery operates much faster in converting inorganic substances into organic matter. And while plants require a lot of fuel to sow and harvest and additional fertilizer and fresh water to nourish, algae can be continuously harvested from closed water-based bioreactors that require little additional replenishment other than inorganic fuel supplied in the form of waste gas.

### A2 Small Scale

#### Algae Can Provide Enough Oil For Mass Production – It’s Only Been Developed on a Small-Scale in the Status Quo

Hu et al, 08 (Qiang Hu, Department of Applied Biological Sciences, Arizona State University, Milton Sommerfeld1, Eric Jarvis, National Renewable Energy Laboratory Maria Ghirardi2, Matthew Posewitz3, Michael Seibert2 and Al Darzins, Department of Chemistry and Geochemistry, Colorado School of Mines, Plant Journal, February, “Microalgal triacylglycerols as feedstocks for biofuelproduction: perspectives and advances,” pg Blackwell synergy

Based upon the photosynthetic efficiency and growth potential of algae, theoretical calculations indicate that annual oil production of >30 000 l or about 200 barrels of algal oil per hectare of land may be achievable in mass culture of oleaginous algae, which is 100-fold greater than that of soybeans, a major feedstock currently being used for biodiesel in the USA. While the ‘algae-for-fuel’ concept has been explored in the USA and some other countries, with interest and funding growing and waning according to the fluctuations of the world petroleum oil market over the past few decades, no efforts in algae-based biofuel production have proceeded beyond rather small laboratory or field testing stages. The lipid yields obtained from algal mass culture efforts performed to date fall short of the theoretical maximum (at least 10–20 times lower), and have historically made algal oil production technology prohibitively expensive (Hu et al., 2006; Sheehan et al., 1998).

### A2 Tech Not Ready

#### Algae will be ready for widespread airline use within a few years

PR Newswire 2008 “Sustainable Aviation Starts With Sustainable Policy”; PR Newswire Europe

An interesting part of the programme will be the presentation on second and third generation biofuels. Especially aviation fuel made of algae could offer some real benefits. Within a couple of years an amount of fuel sufficient to cover the need of all of the world's airlines could be produced from algae.

#### The technology to develop algae is ready now

Nikkei Weekly 6/2/08 (nqa, “Algae looking slick as green oil source,”

Technologies already have been developed for separating and extracting the oil. Mixing the culture fluid with isopentane dissolves the oil, and then mixing this with water separates the isopentane for easy removal. Evaporating the liquid leaves the oil behind. The isopentane can be reused, and the algae survive the process so they too can be returned to the culture tanks for further oil production.

#### Algae is ready for production – it just needs a boost

Chief Engineer 08 “Lowly Algae Fuel A New Renewable Energy Boom,” <http://www.chiefengineer.org/content/content_display.cfm/seqnumber_content/3236.htm>

Driven by renewed investment as oil prices push $100 a barrel, Ruan and scores of scientists around the world are racing to turn algae into a commercially viable energy source. Some varieties of algae are as much as 50 percent oil, and that oil can be converted into biodiesel or jet fuel. The biggest challenge is slashing the cost of production, which by one Defense Department estimate is running more than $20 a gallon. “ If you can get algae oils down below $2 a gallon, then you’ll be where you need to be. And there’s a lot of people who think you can,” said Jennifer Holmgren, director of the renewable fuels unit of UOP LLC, an energy subsidiary of Honeywell International Inc. Researchers are trying to figure out how to grow enough of the right strains of algae and how to extract the oil most efficiently. Over the past two years they’ve enjoyed an upsurge in funding from governments, the Pentagon, big oil companies, utilities and venture capital firms. The federal government halted its main algae research program nearly a decade ago, but technology has advanced and oil prices have climbed since then, and an Energy Department lab announced in late October that it was partnering with Chevron Corp., the second-largest U.S. oil company, in the hunt for better strains of algae. “ It’s not backyard inventors at this point at all,” said George Douglas, a spokesman for the Energy Department’s National Renewable Energy Laboratory. “It’s folks with experience to move it forward.”

### A2 water use

#### Recycled water solves

Biello 11

(David Biello is a writer at the Scientific American interviewing J. Craig Venter, geneticist and entrepreneur, 11-15-11, “[Can Algae Feed the World and Fuel the Planet? A Q&A with Craig Venter](http://www.scientificamerican.com/article.cfm?id=can-algae-feed-the-world-and-fuel-the-planet&print=true)”, <http://www.scientificamerican.com/article.cfm?id=can-algae-feed-the-world-and-fuel-the-planet&print=true>)

How will you get nutrients, such as phosphorus and nitrogen, to stimulate algae growth? We need three major ingredients: CO2, sunlight and seawater, aside from having the facility and refinery to convert all those things. We're looking at sites around the world that have the major ingredients. It helps if it's near a major refinery because that limits shipping distances. Moving billions of gallons of hydrocarbons around is expensive. But refineries are also a good source of [concentrated CO2](http://www.scientificamerican.com/article.cfm?id=first-look-at-carbon-capture-and-storage). It's the integration of the entire process. [Synthetic Genomics] is not trying to become a fuel company. You won't see SGI gas stations out there, we're leaving that to ExxonMobil. We will help them shift the source of hydrocarbons to [material recycled from CO2](http://www.scientificamerican.com/article.cfm?id=turning-carbon-dioxide-back-into-fuel). What about water? Algae would need a lot of it to grow. We think we can recycle a lot of what we're doing. … Novel technologies for recycling wastewater [like [**microbial fuel cells**](http://www.scientificamerican.com/article.cfm?id=microbes-convert-wastewat)]. Water is a problem, recycling it and capturing back all the nutrients. If you have to add tons of fertilizer per acre you're not really solving anything.

### A2 Won’t Work

#### Previous trials relied on poor tech—more work in the field can make algae more productive

Michael Briggs (Physics @ University of New Hampshire) 2004

<http://www.unh.edu/p2/biodiesel/article_alge.html>

While the work on algae for fuel production done in the 1980s and 1990s focused almost entirely on the simple open pond approach, most groups now working in this field (including our collaboration) have shifted to focusing on the use of proprietary photobioreactors. The primary reason being that most of the problems encountered by prior work (takeover by low oil strains, vulnerability to temperature fluctuations, high evaporation losses, etc.) are primarily a result of using open ponds. Going with enclosed photobioreactors can immediately solve the bulk of the problems encountered by prior research. The obvious drawback though is cost - any photobioreactor design is going to be have a higher capital cost than a simple, open pond. At this point, a key factor in making algal biodiesel a commercial reality is the development of photobioreactors that can offer high yields (optimization of light path, etc.), but be built inexpensively enough to offer a reasonable payback rate (otherwise no company would be interested in building them). Improving processing technologies, and designing an integrated system to tie the algae production into other processes (i.e. wastestream treatment, power plant emissions reduction, etc.), can further improve the economics and payback rate. UNH and our collaborators are currently focusing on these issues, with the goal of making algal biodiesel a commercial reality.